DATA PROCESSING

FOR

Business Education Departments

IN

Pennsylvania's Public Schools

BULLETIN 276

COMMONWEALTH OF PENNSYLVANIA • 1964
DEPARTMENT OF PUBLIC INSTRUCTION • Harrisburg

Message From the Superintendent of Public Instruction

A significant number of additional workers will be needed to operate unit record equipment and computers in the coming decade. Manufacturers of data processing equipment trained most of the necessary employees when office automation was in its infancy. Due to the rapid acceptance and expansion of data processing, manufacturers no longer find it possible to train the necessary personnel. Schools, in the past, have trained business pupils in the basic skills of office procedure. It seems reasonable to assume this trend should be continued in the data processing area. The need is apparent and high schools must continue to teach business students basic skills as well as the principles of data processing.

Transcending the area to which this publication is addressed, an attempt has been made to show how everyone's life is affected as a result of increased use of data processing equipment. The gap between automation and the skills taught to business pupils could become wider if schools do not help pupils adjust to a changing world. Business teachers should be retrained for this vital role, because data processing will affect and be a part of practically every office within the next few years.

The Department of Public Instruction is indebted to Dr. James LaSalle of the Shippensburg State College for his work on this publication. Doctor LaSalle wrote Chapters VI to X and the appendices, and reviewed and did preliminary editing on the first five chapters. The Department of Public Instruction would like to express its appreciation to Doctor LaSalle for his help and the Shippensburg State College for making this assistance possible.

Appreciation is extended to the business educators in Pennsylvania who reviewed and offered valuable suggestions that have been included in this course of study. In addition to the educators whose names are indicated on page 105, Dr. Louis C. Nanassy, State College, Montclair, New Jersey, reviewed this manuscript when he served as a visiting professor at the Shippensburg State College, and Mr. Richard S. Stumpf, Technical Education Advisor, Department of Public Instruction, assisted with the development of this guide. A word of thanks also is extended to the manufacturing concerns which furnished illustrations.

This publication was developed in an effort to guide teachers who will be offering instruction in this area. Administrators and teachers are urged to send their comments pertaining to this bulletin to William H. Selden, Jr., Consultant, Business Education, Department of Public Instruction, Harrisburg, Pennsylvania.

George W. Hoffman

Acting Superintendent of Public Instruction

August 1964

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Preface

Data processing is an area in which business teachers have had little or no formal college education. It also is an area in which most of these teachers have a limited background. Therefore, the main purpose of Bulletin 276 is to explain *what* rather than *how.* This guide has been prepared to give business teachers a background in data processing. To those who may have acquired a background, it should serve as a source of review.

With the possible exception of Chapters I, II, and IX, most of the information in this bulletin can be used as reference in preparing daily lesson plans. Chapter IX goes into rather extensive detail on unit record equipment, and should give the teacher a good insight into this type of hardware. It will help him answer questions which students raise, select equipment that may be procured, and converse more intelligently with businessmen about unit record equipment.

Although the main purpose of this publication is to talk about the *what,* this does not imply that the *how* (teaching technique) is unimportant. To the contrary, teaching techniques are most important. A data processing course is almost meaningless unless there are organized practice materials, and to be successful a teacher needs to do more than discuss the assigned topics.

CHAPTER ONE

Demands Upon Business Education

Wonderful are the devices that are being produced daily in the business world, and from present indications, the time is not far distant when all office work will be done automatically and where business will be merely a matter of pushing buttons, turning electric switches, and waiting for the result . . . typewriter girls, bookkeepers, and even office boys will lose their jobs . . .

The above sounds as if it may have been written on September 8, 1957; instead it appeared in a newspaper on September 8, 1907. Since that time the number of clerical workers has increased significantly.

When adding and calculating machines were introduced into the office, people said it would no longer be necessary to teach business mathematics. To the contrary, the need to teach this subject is greater now than in the past. Businessmen point out time and again that students are deficient in mathematics—fundamentals, decimals, fractions, percentage, and the like.

A similar claim was made when bookkeeping machines were first used in the business office. However, as many business educators and businessmen suspected, the need for employees with a background in bookkeeping and accounting has grown and will continue to grow in the foreseeable future. A person who operates a bookkeeping machine can work much more effectively if he has an understanding of bookkeeping and accounting.

Also, when the typewriter came into being it was pointed out that one clerk could do the work of several. This is true; but the typewriter created a demand for a significantly greater number of typewritten documents. Hence, the number of typists is increasing continuously. Even with the use of automatic typewriters and copying machines, this trend continues. When the typewriter came into its own the office clerk needed a broader background than previously. In addition to a background in grammar he had to learn how to operate a typewriter with a high degree of accuracy as well as a certain amount of speed.

Once again, history repeats itself, this time in the "era of data processing." Not only do present office employees need the skills and knowledge required in the past, they need additional background for employment in the business office of today. This is a case in point of where progress

does not adapt itself to people, instead people must adapt themselves to progress. Business is expanding so rapidly that ways are being used for recording information in a manner undreamed of 25 years ago. The more complicated the machine or the system of operation, the greater is the background needed for one to be an employee in a modern office. Studies made by private enterprise and the U. S. Department of Labor indicate that instead of reducing the number of office employees, business data processing tends to increase the office staff.

Data processing is the mechanical or electronic handling of financial, statistical, and related information for the production of records and reports. It includes the processing of information obtained at the source in accordance with rules and procedures. Data processing offers business education a new challenge and a new responsibility.

A New Challenge

The impact of new techniques brought about by automation forces business to convert rapidly to data processing machines for fact accumulation and computation. Consequently, office procedures are changing and when major changes are made in the business office a revision of the business curriculum becomes necessary.

To meet the challenge that data processing presents, business educators should ascertain the specific changes that are taking place in office occupations, especially in data processing. This should be done periodically and can be accomplished by making surveys of business offices, by making follow-up studies of business graduates, by setting up joint committees of businessmen and business educators, and by establishing lay-advisory committees. Detailed information about surveys of business offices and follow-up studies of graduates may be found in a July 1963 Department of Public Instruction publication, *Questionnaires for the Use of a School District in Making a Survey of Business Offices and Stores and a Follow-Up Study for Graduates of the Business Course.*

A New Responsibility

One of the immediate responsibilities of the secondary schools in Pennsylvania is to introduce into the curriculum the findings of the surveys, follow-up studies, etc. Research indicates that this can be done by establishing a one-semester or one-year basic orientation, principles, survey, or theory course in data processing. This course definitely should be taught to vocational business pupils and to pupils in other curriculums who might profit by this experience. Data processing might best be offered in grade twelve, and its objectives are to provide pupils with a basic orientation of business data processing and a working knowledge

of the principles involved. A suggested outline for this course is given in the next chapter.

To offer a course in data processing to high school pupils, a teacher should have specialized training. This might include one or more college courses in data processing or attendance at a business data processing teacher education institute such as those that have been conducted under the leadership of the Technical Education Branch of the U. S. Office of Education. In addition teachers may keep current by

1. reading data processing material.
2. taking field trips through automated offices.
3. discussing data processing with personnel in the field—salesmen, programmers, and the like.
4. bringing businessmen into the school to discuss data processing with the entire business education staff.
5. working with data processing equipment during vacation periods.
6. attending workshops.

Educators, as well as others not directly associated with the data processing industry, do not know what the computer of tomorrow will be like. Therefore, teachers have the responsibility of *emphasizing* to pupils that their education will be a lifelong process. A young person cannot go into data processing today and expect to succeed unless he is willing to learn and master new skills.

At one time workers felt their skills could be used indefinitely, and this created a pessimistic attitude toward taking additional training. However, when a person realizes that retraining is a part of life, a part of keeping up to date with one's chosen field, a part of getting ahead, he will benefit from this experience.

Many people view business data processing and the language of office automation as being complex and difficult to understand. The major factor that has a tendency to make the situation seem complicated is the change from manual to automated procedures which requires time and patience. In the final analysis data processing machines save time, money, and/or manpower, and their use provides for better services at lower costs. Business educators have the responsibility to discuss these facts with their pupils.

CHAPTER TWO

Secondary School Program

In the early days of data processing, employers expected the computer manufacturers to train employees who would work with the computer and unit record equipment. Because of the rapid turnover (approximately 25 percent a year) of clerical workers and the increasing number of offices using data processing equipment, the task has become impossible for computer manufacturers. Today the businessman is looking to the business educator to do at least the preliminary training.

To meet the challenge brought about by data processing, the contemporary business education program should be evaluated continuously. Business educators must analyze new developments periodically and revise the curriculum accordingly. By so doing, young people will be better trained to work in automated offices.

The demand for white collar workers is expected to expand significantly, thus creating a corresponding demand for additional education facilities. Vocational preparation for data processing personnel has become a national necessity. If more pupils would have received this training, America might not be facing the problem of increased teen-age unemployment.

Basic and General Background

Many competencies are needed by those who aspire to work in the area of data processing. The basic requirements are

1. command of fundamental skills—reading, figuring, speaking, spelling, and writing. Accuracy is important in the preparation of input data, as one error will be carried through the entire process. This is the GIGO concept (garbage in = garbage out).
2. skill to operate a typewriter and a key punch.
3. knowledge and understanding of bookkeeping and accounting, filing, business communications including mailing procedures, office procedures, business forms, and reference materials.

General requirements include

1. ability to see relationships (for instance, one set of figures against the other, as well as one job to another).
2. maturity of judgment.
3. ability to analyze problems before solving them (logical thinking).
4. efficient work habits and methods.

5. knowledge of business organization and the more common office procedures.
6. understanding of business ethics.
7. ability to adapt to change.

Over and beyond the items mentioned above, there are requirements acquired or learned while working in data processing. These are

1. research ability.
2. trade information and terminology.
3. company policies.
4. specialized company procedures.
5. general equipment characteristics.

Detailed information about vocational business and other subjects that should be taken by pupils who plan to prepare for the field of data processing follows:

Algebra

One of the more important subjects that business pupils interested in data processing should study is algebra. This is especially true for those who aspire to work with computers. Here, the ability to see mathematical relationships and to think sequentially is required. A description of the type of algebra that should be taught to business pupils is found in a 1963 Department of Public Instruction publication, *Electronic Digital Computers in Secondary School Mathematics.*

Bookkeeping and Accounting

One of the important values of bookkeeping and accounting is the understanding it develops regarding the operation of a business and the inter-relationships of the various departments within the business. Another understanding that may be developed is the possible effect of accounting statements on the management of a business. Accordingly, the theoretical aspects of the course need to be stressed.

Data processing will not change the fundamentals of bookkeeping and accounting; however, it will change the details of entry making. It will increase the need for an understanding of double-entry bookkeeping and financial statements. Therefore, high school bookkeeping and accounting teachers will need to continuously ask, *why?*

As Forkner[1] pointed out in comparing bookkeeping with data processing:

> *. . . even though automated equipment is used, it is still necessary to know and to understand the records automated equipment can produce. Of even more importance is the fact that before business data can be organized for automatic processing it is necessary to know the fundamentals of bookkeeping because machines and other automated equipment can only produce the kinds of records that they are directed to produce. This means that the one who plans the work for data processing on automated equipment must know what accounts are to be debited and what accounts are to be credited for each type of transaction.*
>
> *The person who plans the steps which the automated equipment is to perform is called a programmer. He, for example, programs the steps the automated equipment is to take in order to produce a sales journal, a purchases journal, and the like. He programs the steps the equipment is to take to produce monthly statements for customers. In fact, he must program every step in the bookkeeping process just as the hand bookkeeper programs his steps in recording and posting of business data.*

Students who plan to enter the field of data processing should be encouraged to study as much bookkeeping and accounting as possible. The data processing course described on page 12 is an adjunct to bookkeeping and accounting.

Business Organization and Management

A course in business organization and management is taught in many secondary schools outside of the Commonwealth, and the schools of Pennsylvania might well consider offering this subject. It should be elected by business pupils who are interested in a data processing career. Business organization and management can become an increasingly important subject as business methods and procedures continue to change. While studying business organization and management pupils will be afforded the opportunity to

1. develop a better understanding of how businesses are organized and directed.
2. gain an appreciation of the interdependence of businesses.
3. receive information about the legal, financial, and directional organization of business.
4. acquire a knowledge about business cycles.

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[1] Hamden L. Forkner, "Bookkeeping Is Data Processing," *The Balance Sheet*, 43:268, February, 1962.

5. understand the importance and functions of business recordkeeping and business budgets.
6. increase their knowledge of money and credit and the safeguarding of business investments.
7. learn about unfair business practices, socially undesirable capital structures, and organizational abuses.
8. become acquainted with the interrelated rights and responsibilities of labor, management, and government.

Data Processing

As indicated in the first chapter, one of the immediate responsibilities of the secondary schools in Pennsylvania is to offer a basic orientation or survey course in data processing. In the development and refinement of course content the material should be presented in accordance with the needs of pupils in the employment area where they will seek jobs. For instance, if there is a preponderance of one type of computer, some instruction might be given on it. Since instruction in data processing is still in its embryonic stage, the following outline appears to be desirable but it should be considered as a guide:

1. History of Data Processing (Chapter III. Data Processing in Retrospect and Prospect)
2. Economic Changes Caused by Data Processing (Chapter IV. Effect of Data Processing on the Economy)
3. Extensiveness of Data Processing (Chapter V. Data Processing Everywhere)
4. Increased Use of Paper (Chapter VI. Data Processing and the Paper Explosion)
5. New Jobs (Chapter VII. Employment Opportunities)
6. Common Language Media (Chapter VIII. Common Language Media)
7. Unit Record Equipment (Chapter IX. Unit Record Equipment)
8. Computers (Chapter X. Computers)

Since this is designed as a principles or theory course, equipment is not necessary for classroom instruction. When equipment is not available, a minimum of three field trips to data processing installations located in industries or schools is strongly recommended. It might be possible to make use of equipment that has been procured by the school for scheduling pupils, preparing report cards, and the like. Another possibility is

to use, on a cooperative basis, equipment that is based in a nearby area technical school.

The availability of equipment should help develop pupil interest, and enhance the value of a principles or theory course in data processing. Equipment is ideal for use in problem solving, and organized practice material should be used to the extent possible. For instance, it is not advisable to talk about a punched card and then move to another topic. A pupil should feel it, work with it, and see the original document from which the information was punched. Sample exercises may be found in Appendix B.

A key punch is suggested if a school can afford to rent or purchase only one machine. Against the possibility that three machines can be procured, a key punch, sorter, and accounting machine might be considered. In organizing a more comprehensive installation the following machines are suggested: key punch, verifier, interpreter, sorter, collator, reproducer, and accounting machine. See Chapter IX for detailed information on each machine.

The movement of American business into data processing is, in itself, justification for offering a course of this nature. However, the following statement[1] by an employment manager of a large insurance company pinpoints the need:

> *Within the past two days I interviewed ten business education graduates of local area high schools. All ten passed our general intelligence and clerical aptitude tests with flying colors. Two of them had completed high school survey courses in data processing and also knew how to operate a keypunch. I selected both of them to fill two present openings. Neither of them will be immediately employed in our punched card installation, but the fact that they had a working knowledge of the principles of data processing made them stand out head and shoulders above the other eight.*

In this same article, Greiner pointed out the following reasons why business pupils should have a background in data processing:

> *High school graduates with a reasonable amount of technical training in data processing can qualify for many of the "apprentice" operator and programmer positions that . . . data processing installations will create . . .*
>
> *Business education graduates with a knowledge of data processing will receive preferred consideration for clerical positions in the fringe areas which prepare and edit data to be processed, or work with information and reports that have been prepared in a data processing installation.*

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[1] William E. Greiner, "Are Your Graduates Qualified to Compete in Today's Labor Market?" *Business Education World*, 44:9, December, 1963.

Qualified clerical employees in these fringe areas represent an "in-house" pool of semi-trained personnel who could, and probably would, be promoted to career technical positions in their employer's data processing installations as openings were available.

Office Practice (Machines)

Studies indicate the majority of businesses, including those already automated, are still purchasing conventional equipment such as adding-listing machines and rotary calculators. However, cursory studies indicate that bookkeeping machines and key-driven calculators are not being used as extensively as in the past. The decrease in the number of key-driven calculators used in business offices is significant.

Oliverio[1] made an interesting as well as timely observation regarding machines in pointing out the following:

> *When viewing any type of change, it is easy to focus on the new aspects and fail to see the relationship of the old to the new. For example, a highly complicated business machine may look amazingly different from former machines; however, a careful look at the new machine and its operations will reveal that the operator is essentially an operator of a ten-key machine. It is important that the business teacher assess the changes with calmness and intelligence.*

Pupils who plan to go into data processing should receive instruction on a key punch. Standards to be attained in operating this machine should be determined. If a school does not have a key punch, it can obtain typewriters with a key punch simulator keyboard and/or key punch simulator element.

Typewriting

In typewriting, emphasis should be placed on production, or the tools of production, rather than on timed writings. A comprehension of grammar, including spelling and vocabulary, and the ability to understand what is being typed are the factors leading to success in typewriting. Accuracy and neatness also are important attributes of a successful typist.

There is an increasing need for competent typists in data processing. In addition to accuracy and a reasonable degree of speed, the ability to proofread is important.

[1] Mary Ellen Oliverio, "Social Changes and Business Education," *Business Education Forum*, 14:10, January, 1960.

Other Subjects

Taylor's[1] article regarding the role of business education in a changing business world is one of the most practical and thought provoking that has been prepared to date. This manuscript contains some excellent information regarding specific subjects.

With regard to business English, Taylor states.

> *The problem of communications is one of the major concerns of business management. As business organizations become larger and more complex, it becomes increasingly more difficult for top management to know what is going on in all parts of the organization. Accurate communication, consequently, takes on significance of a high order. Accordingly, the teacher of business English will be certain that his students appreciate the fact that every letter, memorandum, and report says exactly what it is supposed to say, in perfect English without excess words, inappropriate terminology, or ambiguous phrases. He will be certain that every student realizes the need to make every report entirely accurate and in line with the needs, not so much of his teacher, but of some business organization in which he might be employed.*

With regard to business law, Taylor states.

> *A main justification for teaching business law in high school is to give the future business office worker an appreciation of the importance of the law as an aid and a guide in the operation of a successful business enterprise. Throughout the course and in every case discussed, the teacher must be sure that the student is not so preoccupied with the detailed outcome of a case as with the fundamental nature of legal problems which arise and the need for competent legal aid in the solution of those problems. The responsible business law teacher will inculcate in his students an understanding of the nature of legal problems and an appreciation of the fact that when such problems arise, their handling and solution must be based on the advice of competent and technical legal assistance.*

With regard to business mathematics, Taylor states.

> *The actual computations of interest, discount, percentages, etc., are now performed almost entirely on machines. Every good teacher of business arithmetic, therefore, in addition to teaching the underlying principles, should make certain that each of his students knows the capabilities of the modern computing machines, knows how to use them, and understands the meaning of his results. The job of the teacher of business arithmetic becomes, then, more than the teaching of arithmetic; it includes also the training of the individual student*

[1] James R. Taylor, "A Businessman Comments on Business Education in a Changing Business World," *American Business Education*, 28:59-60, October, 1961.

in the use and appreciation of the modern devices which take much of the tediousness out of otherwise tiresome and routine work.

Teaching Procedures

There are many methods which can be used in teaching principles and concepts of data processing. The following were reported by Parfet[1] in his study of how business teachers in Pennsylvania were introducing electronic data processing:

1. *Field trips to businesses and industries using EDP equipment are arranged.*
2. *Students make reports on EDP.*
3. *Specialized EDP vocabulary is studied.*
4. *Outside reading in this field is assigned or encouraged.*
5. *Free booklets are obtained from industry for both classroom use and class reports by individual students.*
6. *EDP equipment is demonstrated in the classroom.*
7. *Films, slides and filmstrips are obtained from industry to show types of equipment and employment possibilities.*
8. *Displays of equipment and current developments in the EDP field are mounted on bulletin boards.*
9. *Class discussions on office automation are held.*
10. *Outside speakers are brought in from offices using EDP equipment and from equipment manufacturers' representatives.*
11. *Student workshops are held with the co-operation of industry.*
12. *A career conference on EDP is scheduled on Career Day for interested students.*

Reviewing case studies of automated businesses and the reasons for conversion is another teaching procedure that might be used.

Expansion of Secondary School Program

Few people realize the tremendous technological progress made in the past decade by American industries. This progress has brought about far reaching changes in employment patterns and has created many emerging occupations. Consequently, the average person may need to be retrained many times in his lifetime.

[1] James A. Parfet, "Electronic Data Processing: Why? What? How? When?" *Business Education World,* 42:9-11, February, 1962.

In a presentation[1] made at an Administrative Management Society seminar, Robert E. Slaughter said:

> *In America, we are moving into a "continuing learning society." Office automation is helping to create the need for continuing learning.*

The secondary school should assume the responsibility for at least some of this training. All educators need to be concerned with equipping underemployed and unemployed persons with the knowledge and skills necessary for those who wish to be useful and productive citizens. This will be a continuous job as we progress and maintain our leadership in the military and in productivity, particularly in this period of international competition.

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[1] *Automation Impact on Training of Present and Future Office Employees* (Proceedings of a problem-solving seminar, Willow Grove, Pennsylvania: Administrative Management Society), p. 43.

CHAPTER THREE

Data Processing in Retrospect and Prospect

When the history of our age is written, it will record three profoundly important technological developments: (1) nuclear energy, which tremendously increases the amount of energy available to do the world's work; (2) automation, which greatly increases man's ability to use tools; and (3) the computer, which multiplies man's ability to do mental work. Some of our engineers believe that of these three, the computer will bring the greatest benefit to mankind.

The above statement was made several years ago by the then president of General Electric Company, Mr. Ralph Cordiner.

In Retrospect

In going back through the corridors of history one will find that automation on the farm, in the factory, and in the home was started by and received its stimulus from private industry and individuals. However, to a greater extent government is responsible for the growth in the early stages of data processing.

Irrespective of the fact that adding machines and calculators were used in the seventeenth century, it is generally agreed that business data processing, or at least a crude form of it, is a product of the nineteenth century. Some claim that business data processing came into being in 1822 when Charles Babbage developed a "difference engine" for calculating mathematical tables. Babbage, in 1833, developed an "analytical engine" which was the first internally stored program computer. Others feel that 1887 is a more significant date as Dr. Herman Hollerith of the U.S. Census Bureau developed a system of recording, compiling, and tabulating census facts.

The Bureau of the Census, under the leadership of Herman Hollerith, installed a set of the mechanical equipment in time to process the statistical data of the 1890 census, which was tabulated in two and a half years. This tenth decennial census became the first large-scale data processing operation to use the punched card system. A pantograph punch, a hand-operated gang punch, and a manual-feed unit counter and sorting box were included in the first installation. By 1900 Hollerith had developed an automatic electric sorting machine that could sort at the rate of 300 cards a minute, a semi-automatic unit tabulator, and a key-punch machine.

Hollerith left the Census Bureau in 1903 to form the Tabulating Machine Company. A few years later the Bureau organized its own Mechanical Laboratory and engaged James Powers, a statistical engineer, to develop a new concept in punching machines, but continuing the use of the unit card principle. This proved so successful that three hundred of his machines in addition to the sorters and tabulators developed by the Bureau were used exclusively in processing the data of the 1910 census.

In 1911 Powers resigned from the Bureau to form the Powers Accounting Machine Company, which was later acquired by Remington Rand Corporation. A year later the International Business Machines Corporation emerged from the Tabulating Machine Company.

> *Improvements in punched card equipment before 1930, made by successors to the Hollerith and Powers patents, included the mechanical verifer and electric key-punch (1917); the single-deck sorter, and alphabetic printing tabulator (1919); an electric duplicating key-punch for simultaneous punching and typing, and an 80-column card and general-purpose accounting machine (1928).*[1]

Machine developments from 1930 to 1950 include: numerical interpreters (1930); a test scoring machine and alphabetic printing punch (1933); a collator to merge and separate cards (1936); mark-sensing for cards (1939); a cross-adding punch (1943); and an electronic statistical machine (1949).

The history of computers dates from 1937, when Howard H. Aiken conceived a mechanical, sequential computer capable of following a sequence of steps punched into a tape. Aiken successfully completed the Mark I, officially named Automatic Sequence Controlled Computer, in 1944, after seven years of effort.

In the 1940's electronic computers were developed and used to solve acute problems such as gunfire control. The winning of World War II can be attributed in some measure to the use of these computers. It wasn't until after 1950 that computers were used for the solving of problems outside the fields of engineering and science.

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[1] Robert H. Gregory and Richard L. Van Horn, *Automatic Data Processing Systems* (San Francisco: Wadsworth Publishing Company, Inc., 1960), p. 628.

The first all-electric computer was developed by John W. Mauchly and J. Presper Eckert at the Moore School of Engineering of the University of Pennsylvania. Under the combined leadership of Mauchley and Eckert, a University group developed this computer and named it Eniac, the acronym for *E*lectronic *N*umerical *I*ntegrator *a*nd *C*alculator, between 1943 and 1945. The work on the Eniac led to designs for larger machines with greater capacity and higher speed. From these developments and discoveries was developed the Edvac (*E*lectronic *D*iscrete *Va*riable *C*omputer). The Edvac was the forerunner of Univac (*Univ*ersal *A*utomatic *C*omputer), which became the world's first commercial electronic data processing machine. The Univac was made commercially available in 1951. A significant feature of Univac over its forerunners was its ability to handle alphabetics and certain typewritten characters as well as numerics.

In compiling the statistics of the 1950 census, the U.S. Census Bureau again did some data processing pioneering by being the first governmental agency to use an electronic computer. This computer, Univac I, was delivered to the Census Bureau in 1951 and was in operation seven days a week until the latter part of 1963 when it was retired to the Smithsonian Institute.

Late in 1952 the eyes of the American people were opened when a computer, after receiving some early returns of the Presidential election between Eisenhower and Stevenson, accurately predicted the outcome of the election. By 1954 the first computer was installed in private industry. Since then, computers and unit record equipment have been installed so rapidly that it is difficult to keep pace with the increased use of this equipment. Another development toward the end of the "fabulous fifties" was the introduction and use of medium-sized and small computers. A small computer is generally considered one that costs less than $50,000, a medium-sized computer between $50,000 and $500,000, and a large computer over $500,000.

A major development in computers was unveiled early in 1964 by a leading manufacturer of the industry. Early computers were operated by means of vacuum tubes that were bulky and demanded considerable power. The use of tiny transistors in place of the vacuum tubes was a step forward. These units require less power and occupy less space in the computer. After considerable research, a new generation of computing equipment has been developed. The micro-electronic circuits that make up the new system consist of tiny transistors and diodes mounted on circuits which are only 28-thousandths of an inch thick. This development provides bulk storage for as many as eight million characters, each available for use in processing in eight millionths of a second.

In Prospect

In looking into the future, it is believed that the major changes in data processing will be with computers. It is doubtful if unit record equipment, such as the key punch and sorter, will change materially.

As indicated, the basic change to be expected in the computer is that it will become smaller and more compact. According to predictions, computers no larger than a shoe box will be available by 1970. These will compare with the early room-size computers. Already there are computers that can be operated without air conditioning, plugged into a standard electrical outlet, and moved into an office with a standard-sized door.

A Kiplinger[1] release indicated this point of view when it stated:

> *A new slant on computers: Their size and cost are coming down, and as a result, more medium-sized and even small firms are using them. .*
>
> *Computers are becoming commonplace . . . and a competitive factor. Firms that make successful and profitable use gain positive advantages.*

Another possible trend in data processing is the use of computers in homes. It is believed that apartments will be the first to use them, and tenants can pay additional monthly rental just as they pay additional rental by using the garage facilities of apartment houses. Here, computers can be used to set up personal budgets, answer questions, and the like. In the distant future each home might have access to a computer, perhaps through the telephone. Dr. George L. Haller, General Electric's Vice President for Advanced Technology Services, points out that it would be possible for the computer to "make up your grocery lists, plan your menus, remind you of appointments, balance your check book, pay your household bills, easily figure out your income tax and give you the best tax break while at it."

The need for training a substantial number of competent specialists and technicians cannot be overlooked. Studies indicate that by 1975 approximately three million people will be employed by data processing operations in the United States. This is more than triple the number now employed.

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[1] Austin Kiplinger, *The Kiplinger Washington Letter* (Washington, D.C. The Kiplinger Washington Editors, February 7, 1964).

CHAPTER FOUR

Effect of Data Processing on the Economy

The present and future of data processing will have a far-reaching effect upon the lives of the American people. In conquering new frontiers, it has created problems that accord education one of its biggest challenges.

To appreciate and understand the ramifications of data processing, high school pupils will have to be cognizant of the effect it has on the business world, on present and future employment, on presently employed as well as prospective office employees, and on their future, especially if a high school education is not attained.

Effect of Data Processing on Business

Data processing may affect office work in at least two areas: First, communication—preparation and transmittal of letters, reports, memorandums, and the like. Second, recordkeeping—involving dollars and cents in work such as payroll, and statistical work such as inventory. In the area of inquiry and reply where ability to make decisions is needed, data processing may not offer much relief. In the field of recordkeeping, data processing is rapidly revolutionizing not only the work being done but also the jobs of those employed in this area.

Business has grown so rapidly in magnitude and complexity that it is no longer possible or desirable to collect, file, and retrieve information by manual and mechanical means. In addition to the magnitude and complexity of business, other factors—government reports, increasing number of payroll deductions, limited supply of properly trained clerical workers, and demand for better services—have increased the volume of office work. If conventional methods were used, business could not operate as efficiently as it does.

Data processing is a mark of progress for at least two reasons. First, it has made the processing of data more efficient and more accurate. Second, it has made possible the use of data that formerly were not available because of the expense involved in processing this information. Although each business has been affected in a different way, there is a similarity in office routine from which generalizations can be drawn.

Among the many changes taking place in American business is management's requirement for increased information to meet the demand of competition which becomes keener each day. A lack of statistical information, or built-in control, can cripple a business in a short period of time.

Because of this and the additional information that must be submitted to the government, paper work is increasing at an inconceivable rate.

On the other hand, some businesses have reached the point where too much data for practical use have become available. Not all of the information that is accumulated can be used in decision making or reports. Therefore, the wise selection of data to use in different situations is becoming increasingly important.

Perhaps the greatest contribution of data processing is that management receives information needed to make decisions shortly after the close of a month, quarter, or year. This might be considered more important than the job done in accounting, in payroll, and in other operations of a computer. Management, during the early days of American business, would receive their report for one month (March) by the end of the next month (April). With punched card equipment it was received before the middle of the month (April 10-14), and with a computer it is received on the first and not later than the second day of the next month (April 1-2).

Small businesses are using data processing more than formerly. First, cheaper and more compact computers are available. Second, a market for used computers has developed. Third, service bureaus have been established by computer manufacturers or independent businessmen. Fourth, cooperative data processing centers have been established by firms with similar operations.

There will be a need for more clerks in offices that already have a large clerical force, such as banking, insurance, real estate, government, transportation, and public utilities. Although manufacturing also is a large employer of clerical personnel, service industries will have more job opportunities than those that produce goods. Firms engaged in, or allied to, the data processing industry will have a need for a much greater number of clerical employees.

Clerical workers will have to be better trained than in the past, as the need for personnel to do routine, repetitive work is decreasing rapidly. Until such time as schools have a chance to revise their program of instruction, private industry will have to do some of the training.

Effect of Data Processing on Employment

The clerical and kindred occupations classification has been the fastest growing area of employment since 1900 and represents the second largest occupational group in the nation. It consists of approximately 10.5 million (2.6 million secretaries, stenographers, and typists, and 7.9 million other clerical employees), or 15 percent of the total employed in America.

Between 1900 and 1950 the number of employees in this area increased 725 percent, and between 1950 and 1960, 32 percent. According to the U.S. Department of Labor, 14.2 million, or 16.2 percent of the labor force, will be employed in clerical work by 1975, which will represent an increase of approximately 45 percent between 1960 and 1975.

Office work (classified as administrative-clerical) is the second largest occupational group in the military service. More than 20 percent of the enlisted men and probably 80 percent of the officers work in this area. Young men who have acquired an occupational skill in a business education program have an excellent opportunity to receive an office assignment in the military service. Transcending the military service, but of equal importance to the defense of America, is the missile industry where 20 to 25 percent of the employees are office workers.

Clerical employment is still growing, but more slowly than it did at the beginning of this century. However, the rate of growth is still increasing faster than the work force as a whole. This is true irrespective of the development and use of office machines that can do work in minutes that formerly took weeks to accomplish. Data processing will not have an adverse effect on the growth of clerical employment.

A recent release[1] indicated:

> *. . . since World War II, there have been four new white-collar jobs for every job lost in factories and on farms.*
>
> *Here are the figures: white-collar employment rose from 20 million in 1947 to 30 million in 1962, while farm and blue-collar employment dropped from 31.6 million to 29 million.*
>
> *The gain in overall white-collar employment in the 1947-54 period was 18%.*
>
> *The gain in the 1955-62 period was 22%, 4% greater than the earlier period.*
>
> *The same figures for the clerical division of white-collar jobs (which supposedly, have been reduced by office equipment automation) were 13% and 22% which is 9% more than the earlier period.*
>
> *And there is strong evidence that, if there had been more people mentally qualified to fill clerical jobs, the gain would have been even greater.*
>
> *This would indicate that properly qualified young persons need have little fear concerning their employment future.*

[1] Fred G. Clark and Richard Stanton Rimanoczy, "The Things We 'Know' That Are Not So—That Automation Is Reducing White Collar Jobs," Vol. 16, No. 9. (New York: The American Economic Foundation, September, 1963).

The preceding facts were researched by the Columbia University Bureau of Applied Social Research.

Clague[1] went into further detail when he stated:

> *For the past two decades or more there has been a marked shift of employment between blue-collar and white-collar jobs. This doesn't mean that some blue-collar occupations are not growing, many of them are; but the white-collar group is growing much faster. The shift over the years has been away from agriculture, mining, and even manufacturing, and toward wholesale and retail trade, hotels, restaurants, banks, insurance companies, etc. Even within manufacturing industries there is a shift under way from the plant to the office. In the 14 years from 1947 to 1961, there was a decline of about a million production or plant workers in all manufacturing industries combined, while over the same period there was an increase of over one and a half million in office workers.*

The effect of data processing on employment also might be pinpointed to specific areas. In Rochester, New York, a study[2] was made of the 76 firms that had modern data processing equipment. Over a fifteen-year period 3 of the firms had a reduction in employment (due to the nature of the industry rather than data processing), and 25 had an increase in employment of at least 100 percent (in 6 cases the employment was increased tenfold). During the ten year period after the equipment was installed the number of clerical workers increased more than 57 percent.

> *A typical example is the Hickok Mfg. Co., Inc., a manufacturer of men's and boys' belts and buckles, jewelry, small leather goods and similar items. Hickok had a white collar work force of 217 in 1950, when it first installed a tab department. Later, it added a computer to its data processing facilities as well, and it now employs an office force of 447.*
>
> *Michaels Stern & Co., Inc., a manufacturer of men's clothing, had a white collar staff of 73 when it first installed its data processing equipment in 1947. With one slight dip in the intervening years, its white collar work force rose steadily to a peak of 115 employees in 1959.*
>
> *"Unemployment is not an inevitable consequence of automation. Most of what is said and written about it is idle chatter," said W. Allen Wallis, president of the University of Rochester, one of the country's foremost economists and a former Presidential advisor, in addressing a homecoming audience recently. "The problem of unemployment caused by technological change is, at most, negligible—certainly not one percent of the total jobs lost for all reasons."*

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[1] Ewan Clague, "The Employment Outlook for the 1960's," *The Compass,* 26:1-2, March, 1962.
[2] Don Young, "The Rochester Story," Reprint from *Business Automation,* February, 1963.

The immediate effect of a decision to automate is an increase in employment," Wallis continued.

Other studies, too numerous to mention, also indicate that the installation of computers over a long period of time has necessitated the hiring of a greater number of clerical employees. Transfer, upgrading, downgrading, and/or dismissal are immediate results of conversion to computers. In most cases, when careful planning is done, attrition absorbs the excess work force. While there may be a temporary slowdown of employment, a demand for additional office personnel usually starts after the "shakedown" period.

Unfortunately, due to a lack of understanding, there are those who say that 700,000 persons lose their jobs each year because of computer installations. This figure is arrived at by multiplying the number of installations, 5,000, made in one year by the number of employees, 140, affected by the installation of one computer. Instead, what happens is that most of the 140 employees are reassigned within the organization or upgraded to better jobs. Within a period of time the computer will turn out more information than was possible by manual means or with mechanical equipment. Top management will continue to demand an increasing quantity of information and additional personnel will be hired.

Clerical employment, throughout our economy, is continuously reaching new all time highs as machines are preparing information not previously available and a greater number of employees is needed to make this possible. Another change regarding employment is that it will not be necessary to hire a large number of temporary employees for short periods of time.

Effect of Data Processing on Employed Office Personnel

The installation of a computer should be preceded by long-range (12-18 months) planning that includes a feasibility study. Data processing equipment is installed only if it can take care of the increasing complexity of clerical work, reduce unit labor costs, enable a business to provide better service, and/or make possible some result that cannot be accomplished in any other way.

When a business office is being converted to data processing, the work force tends to increase as specialists are needed for specific jobs. After a computer is installed more information will be made available. The increased information often leads to the creation of more jobs. Industries usually train present employees to work in the department or office where data processing is being put into effect. Some employees will be retrained. Others will have to broaden their background and gain additional understandings and competencies.

In large businesses with many branch offices, the accounting system has been centralized. This means fewer employees will work in accounting departments in branch offices and a greater number will be employed in a centralized office. Oftentimes a person working in a branch office does not want to move to a centralized office of the same company.

Almost all clerical and managerial personnel will need an understanding of data processing because it is becoming the nerve center of management and those employees related directly or indirectly to management. This understanding is needed to use the sales forecasts statistics, work schedules, and other information prepared in a data processing department.

Economic history repeats itself and over a period of years there will be not only more but better jobs. More employees will be needed in some businesses because information previously available but not tabulated will be processed and used in the operation of the business. In other businesses there will be an expansion of sales because data processing has provided greater efficiency. To date, an insignificant number of office employees have lost their jobs because of data processing. There is every reason to believe that the same situation will hold true in the future.

Another major effect that data processing will have on personnel is that offices, to a greater extent, will be operating 24 hours per day due to the high monthly rental of computers. This may mean that the percentage of men working in offices will be increased because women do not like to work at night.

Effect of Data Processing on Drop-Outs

In many entry occupations, especially lower-level clerical jobs, competition will increase. The chances of acquiring, adjusting to, and moving ahead in a job situation depend to a great extent on one's background. This is an underlying factor that spells out the need for vocational competency.

As data processing equipment is being used more extensively in business offices, there are fewer jobs for youth who have little formal academic or vocational education. Clerical jobs requiring no specific skill are found, for the most part, in offices that haven't been automated. Work which involves repetitive or routine tasks is disappearing from the business office because it is being done by machines. Therefore, those who plan to drop out of school should be encouraged to stay at least until a high school diploma is earned and a marketable skill learned.

Jobs created or modified by automation require more background than those replaced. The upgrading of jobs is accelerated by automation, and the more involved a business becomes in data processing the greater the need for highly-skilled personnel.

An example of this is the telephone industry where telephone operators are called upon to make more decisions than formerly. Here, girls may not be hired for a specific skill, rather they are employed on the basis of potential in a broad field of work.

Unfortunately, the average American citizen still does not have a high school education. Many of these people have learned a trade or a skill on the job. Today this is becoming increasingly more difficult.

Today's youth should consider data processing as their servant rather than their replacement. Office automation, for those who have prepared themselves for the future, is a challenge, not a threat.

A large percentage of America's unemployed are young people 25 years old or younger. The lack of an adequate education which includes a vocational skill, such as those found in data processing, is the main reason for unemployment. America cannot afford the luxury of having its youth leave school without having learned a salable skill.

CHAPTER FIVE

Data Processing Everywhere

Irrespective of what section, segment, or part of our economy that we examine—government, education, business, industry, services area, and public thoroughfares—data processing is playing an increasingly important role. Data processing seems to affect almost everything that Americans do. Subsequent material illustrates what is happening.

Computer Service Centers

As the American economy expands and technology advances from one stage to the next in an age already complex, a number of new businesses are born. The computer service center is an example of one of the new businesses. During the early stages, computer service centers were organized and operated by computer manufacturers. Now, independent businessmen organize and manage these centers. They serve a useful purpose to small and medium-sized companies by processing their accounting and other record keeping activities.

Social Security Administration

An article[1] in a metropolitan Pennsylvania newspaper brought out the nature of the work data processing is doing in behalf of Americans who fail to claim social security benefits. A file of everyone who has ever had a social security number is maintained in the Social Security Administration Office, Baltimore, Maryland. This master file was run through the data processing machines to determine those eligible but not receiving social security. It was learned that 365,000 citizens eligible for social security benefits did not claim them. The Social Security Office is encountering difficulty in locating a large number of these people because they moved at least once in the ensuing years and did not notify the Social Security Office of a change in address.

Defense Supplies

Velie[2] brought out some interesting facts about inventory in an article in a nationally circulated publication.

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[1] Editorial in *The Philadelphia Inquirer,* August 9, 1962.
[2] Lester Velie, "Automation—Friend or Foe?", *The Reader's Digest,* 81:103, October, 1962.

In Washington, intelligent machines are leveling, in hours, mountains of paper that brigades of government workers once took months to do. For example, computers keep track of every one of the shells, boots, jeeps and two million other items stored by the Defense Supply System in 150 depots. By keeping a daily count of military gear scattered around the globe, computers prevent over-buying, and so have cut military procurement by 2½ billion dollars yearly.

Research

The numerous technological advancements made in America in recent years are to a great extent a result of research accomplished by private industry, colleges, and government. Research is being conducted in almost every field of endeavor, and it is most extensively conducted by private industry.

There is a large duplication of effort because different groups, without knowing it, work on the same or a similar project. Millions, possibly even billions, of dollars a year appear to be wasted in a duplication of effort. Overlapping of research projects in itself is not a waste of time and money providing the overlapping is planned.

In future data processing systems more records of types of research being undertaken will be maintained. This will have the advantage of encouraging research in areas where little or nothing has been done. The use of data processing to coordinate research ultimately will give America a higher standard of living as more and improved products become available.

Automobile Licenses

In September 1963 the Commonwealth of Pennsylvania's Bureau of Motor Vehicles made definite plans to install a computer system to process the state's 5½ million operators' licenses and the 4½ million automobile license renewals. The Bureau of Traffic Safety also will use this system to compile traffic violations.

It is estimated that in a two-year changeover the cost will be approximately $1,200,000 for the preparation of 7,000 square feet of floor space, personnel training, and miscellaneous administrative expenses. The contract with International Business Machines Corporation for a computer and supporting equipment calls for annual rental of $156,000. Irrespective of these expenses, there will be a savings of approximately $700,000 during the first three years of complete operation of this program.

On the Federal level there is a National Driver Registration Service operated by the Bureau of Public Roads. The purpose of this service is to prevent drivers who have lost their licenses in one state because of drunken driving, a fatal accident, and the like from securing a license in another state. The files of this service have information on over 250,000 persons whose right to drive in one state has been suspended. Each day this Bureau checks approximately 6,000 names that it receives of individuals who have applied for a driver's license. Almost every state, the District of Columbia, and four territories participate in this service. This service can prevent a driver with an unsafe driving record from acquiring a license in another state. The safety of the highway is therefore maintained. This is an instance where a computer definitely benefits the public safety.

Banking

A case in point relative to the increase in employment may be found in the banking business, specifically, insured commercial banks. Irrespective of numerous new labor saving devices, the number of personnel employed by banks has increased almost three times as fast as the employment in all non-agricultural industries.

The significant reason for this rise in employment is that the number of checking accounts has increased 40 percent and 75 percent more checks were written in the 1950 decade than in the previous decade. On the average, each check passes through 2 1/3 banks and may be handled as many as 20 times.

In addition to checking accounts, other functions—trust services, issuance of traveler's checks, investment services, facilities for the payment of utility bills, and safe deposit box rentals—increased in volume. Banks are also offering services that weren't rendered previously, such as check-account reconciliation service to large businesses.

Bank employment will rise from 610,000 to approximately 850,000 (or 40 percent) between 1960 and 1970. It is predicted that by 1975 there will be 1,000,000 bank employees, an employment increase of almost 65 percent between 1960 and 1975. Without data processing equipment, it is believed that the employment in 1975 would be 1,225,000. This would indicate that data processing will not reduce the growth in the number of clerical employees, rather it will reduce the rate of growth.

The automatic processing of checks, more than any other single factor, is reducing the rate of growth of clerical employees in banks. In 1959 the American Bankers Association approved the Magnetic Ink Character Recognition (MICR) numerals to be printed on checks for coding purposes. MICR was explained by Keller[1] in an article where he pointed out:

> *MICR represents a major triumph in research efforts to develop a method of using source documents as direct input for automatic data processing. In business, as well as in banking, the conversion of source material to cards or tapes is often the chief stumbling block to successful automation.*
>
> *MICR is more than just another set of initials in the already formidable lexicon of business automation.*
>
> *It involves a common-language which will be imprinted on checks and read by a new breed of machines. This equipment automatically will sort the checks, eliminating the tedious manual effort which bankers say takes up 25% to 40% of their bookkeeping department's time. In more sophisticated systems, the common-language read during check-sorting also will be placed directly into full-scale electronic data processing systems to accomplish complete automatic bookkeeping procedures.*

Perhaps the banking industry has moved into automation too rapidly. For instance, a depositor in the Union Bank and Trust Company, Montgomery, Alabama, withdrew $43,000 that belonged to the account of the Alabama Power Company. The man who withdrew this money found it possible to do so because a clerk recorded a deposit of $43,156 on the wrong ledger sheet. At the time this was reported[2] in a nationally circulated magazine the bank had tried unsuccessfully to recover the money by filing a criminal and then a civil suit. This points up the need for a higher degree of control that includes a minimum of one check by another person on transactions that are handled manually. The story of this "boo-boo" is presented to emphasize the responsibility of teachers to stress accuracy and the need to check work that has been performed.

Medical Research

Medical research is another area which will benefit by data processing. Presently, medical statistics are compiled in a different manner in each hospital. Therefore, any research on a particular case or the effects of a specific drug is extremely cumbersome. In the future, central electronic files of medical records for individuals will be available so that diagnosis, treatment, instrument readings, symptoms, reactions to a disease, and the therapy will be more accurately recorded and stored in an accessible way.

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[1] Arnold E. Keller, "Major Breakthrough in Paper Processing," Reprint from *Management and Business Automation,* March, 1959.

[2] David Nevin, "Boo-boo at the Bank," *Life,* 54:14, June 18, 1963.

Eventually, medical records from a great distance will be secured in seconds.

Electronic physiological-monitoring equipment has been used successfully in surgery and intensive care units. The device can monitor more than sixteen physical functions continuously. Imagine the amount of work this would save the nurse and other hospital personnel. Since there is a constant shortage of nurses, electronic monitoring would enable by far a higher level of nursing care by relieving a nurse of the routine tasks of checking blood pressure, pulse, respirations, temperatures, etc. As stated by Lessing,[1] "The curious affinity of tiny electronic currents with those generated by living organisms themselves would seem to ensure that electronics will write one of the brightest pages in medical science in this century."

Income Tax

When President Lincoln created the Office of the Commissioner of Internal Revenue in the Treasury Department in July, 1862, the staff consisted of the Commissioner and one clerk. The Commissioner read all correspondence from taxpayers personally. Presently, the staff in the Internal Revenue Service (IRS) includes 50,000 employees. Large as the number might be, this staff could not accomplish the necessary work if it were not for the data processing machines located throughout the country.

With the continued use of data processing equipment, IRS has introduced a system called the "Master File Plan." A master file of approximately 80 million accounts recorded on magnetic tape will be established at the National Computer Center, Martinsburg, West Virginia. These records supply tax data which will be updated continuously and contain information accumulated for several years. The master file system will provide greater centralization of routine data processing as well as quick access to the current status of each taxpayer's account.

According to a recent government publication[2] tax returns filed in 1960 showed a 1,500 percent increase compared with 1930. Meanwhile, the number of employees only showed an increase of 318 percent during the same thirty-year period. The greater productivity was largely due to the use of automatic data processing equipment.

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[1] Laurence Lessing, "The Transistorized M.D.," *Fortune*, 68:208, September, 1963.

[2] "Impact of Office Automation in the Internal Revenue Service," Bulletin No. 1364, (Washington, D. C.: United States Government Printing Office, 1963), p. 7.

Buying

Some real estate agencies use data processing to choose one or more homes that most likely will fit the needs and desires of a prospective buyer. The buyer completes a card stating the maximum amount he wishes to pay, minimum number of rooms, size of lot, location, etc. Properties that best meet the standards set forth by the prospective customers are chosen by a computer.

Another example is some large department stores which use a computer to help select gifts. Here, information is placed on a card relative to the age, sex, interest, etc., of the person for whom one plans to purchase a gift. The card will then be run through a computer which will suggest several gifts.

Education

A Pennsylvania State Education Association publication[1] carried an article describing the growing adaptability of computers to educational needs.

> *In a series of demonstrations, based on statistical probability studies of high school pupils, data on recent grades for individual pupils were sent over a commercial teleprinter circuit to a high-speed Honeywell 400 computer located at the Honeywell Electronic Data Processing research center in Wellesley, Mass.*
>
> *The computer aligned a high school pupil's grade-point average against statistical data and immediately transmitted data on the probability of the individual's achievements in five post-high school activities, including attendance at "name" four-year state and junior colleges as well as in non-academic pursuits such as military service, nursing, and general work.*
>
> *Another demonstration showed the individual pupil's probable first-year grades in any of the four college categories, based on his cumulative high school grade achievements.*

This article pointed out that there are many possible areas in which data processing might be used in education, such as decentralized expenditure and budget maintenance, attendance record keeping, test scoring, student appraisal and counseling services, and classroom and student scheduling.

One readily can see that data processing has an effect upon every phase of life. Wherever one may turn, the progress brought about by data processing can be seen.

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[1] "Cross-Country Data," *PSEA Reporter,* 32:73 and 76, March 23, 1964.

CHAPTER SIX

Data Processing and the Paper Explosion

It has been said that the Russians have an iron curtain, the Chinese have a bamboo curtain, and the Americans have a paper curtain. The remark also has been made that when western civilization sinks into oblivion it will leave behind as its monument a mountain of paper. It is rather obvious why western civilization should leave a mountain of paper. Here, ideas are born on paper, nurtured on paper, copyrighted on paper, patented on paper, advertised on paper, and marketed on paper.

". . . paper work is growing at a fantastic rate. Business adds about 15 percent a year to existing records, estimated at 1,500,000,000,000 pieces of paper."[1]

Additional information,[2] of a statistical nature, relative to the paper explosion follows:

> *In the famous Hoover Commission report Edward Leahy estimated that U. S. business now files, stores, and maintains over one trillion pieces of paper, at a storage and maintenance cost of over one cent per sheet per year, and that approximately 175 billion sheets of paper are added to the files annually. Systems of records destruction have lagged behind demands for records retention, causing a steady increase which may double the total volume by 1970.*
>
> *Methods for condensation of required records, such as microfilm, offer the best hope of relief inasmuch as there is little hope that government will diminish its demands for proof of operations or that business will grow less complex.*
>
> *Office furniture industry estimates reveal that approximately 50 million steel letter-filing drawers are in use. Calculating 5,000 sheets per drawer indicates that 250 billion odd sheets are filed.*
>
> *In addition, billions of copies are stored in warehouses, caves, and basements in cartons and boxes "just in case." It is estimated that it costs approximately $75 per file drawer, annually, to maintain current office files, including space, labor, and overhead. This means a total yearly cost of about four billion dollars for file maintenance. Certainly these problems justify careful consideration by business management . . .*

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[1] Esther R. Becker, *What a Secretary Should Know About Automation* (The Dartnell Corporation, Chicago 40, Illinois, 1961), p. 9.

[2] Everett S. Calhoun, "Is the Paper Explosion Subsiding?" *Administrative Management*, 24:24, December, 1963.

The terrific volume of paper that is accumulating in business offices everywhere is becoming a major problem. No one, however, can deny the importance of paper and the role it plays in our way of life. For instance, the weight of the paper that goes into the planning of our largest bombers is too heavy for the bomber to carry. Yet the omission of any one sheet of the paper might well mean that the bomber couldn't fly. Also, in the area of defense, it has been said that the army moves on its stomach. This is no longer so, as a modern army moves on paper.

Another example, one with regard to a specific company, is General Motors.[1] The extensiveness of the files of this company is indicated by the following statements:

> *The firm fills 225,000 file drawers a year with new papers and has 1 million file drawers, which are emptied in an orderly manner to make room for the new papers.*
>
> *One year's file cabinets, five drawers each, would cover five football fields.*
>
> *A single pile of these papers would reach 125 miles into the air—meaning we might get to the moon faster if we could get GM to keep stacking its records on top of each other every year.*

Thus far, mention has been made of America's defense efforts and of one large manufacturing business. There are, however, other areas of our expanding economy in which paper work has grown at a much faster rate.

One example is the Federal government, not to mention state and local governments, with growing social programs and heavy reporting requirements. In a recent year, for instance, almost 400 million tax forms were filed. Also, reports for approximately 150 million social security accounts were submitted four times during the year.

In the service area, the banking and insurance businesses have been growing rapidly. The preceding chapter discussed the increased volume of paperwork in banks—especially in the use of checking accounts. In the life insurance business, over 300 million policies are in force, and the average policy requires upwards of twelve entries per year. An agent of one of America's largest life insurance companies recently said that his company has more different forms than the Federal government.

Irrespective of this avalanche of paper which has become a national problem, little progress has been made to cope with the situation. In 1959, when business offices had been using computers for five years and mechanical equipment for many decades only 20 percent of the paper

[1] News item in the *New York Herald Tribune,* July 31, 1962.

work had been either automated or mechanized. With 80 percent of the paper work still being done by hand methods, it appears that the surface is just being scratched.

The end is not in sight, and the situation will become more critical for the following reasons:[1]

1. *More people. Every year, Census figures are announced, we add nearly 3 million to our population. More people need more houses, cars, food, products, services, each with its own retinue of paper workers. Houses involve mortgages, deeds, taxes. Cars require bills of lading, licenses, financial arrangements . . .*
2. *More people at work. We're adding thousands to the labor force yearly who are working in our factories or performing services . . . It's estimated that the average company handles about 2,000 pieces of paper for every worker on its payroll.*
3. *More products and services. Every few months, something new that we "must" have comes on the market—from white lipstick to swimming pools. Creating new products requires research, with reports, summaries, findings, advertising. We hop in a plane and cross the country in six hours—more tickets, weather reports, flight charts. We buy more on installment. Our current installment debt is $35 billion, up 50 percent since 1951. We open more charge accounts.*
4. *Our way of doing business. Many companies now get their raw materials from remote areas and ship their products all over the world, instead of just serving local markets. Plants and warehouses are decentralized. This requires purchase orders, waybills, invoices, shipping labels, requisitions . . .*
5. *Our Government setup . . . Added to our Government paper work in Washington, D.C., hundreds of records are kept in our state capitals.*

This booklet[2] goes on to state:

> *. . . office efficiency has not kept pace with the factory. Mechanization has increased the productivity of U. S. factories 14 times in the past century. The output of the office worker has been raised only 50 percent. One major reason is that only 15 percent of office work is done with machines, compared to about 90 percent of factory work.*

During the past half century production in America has increased more than 700 percent. In this period 4 new office workers have been added to the gainfully employed for each new factory worker. This indicates our inability to automate to paper work as efficiently as we have automated to production.

In an address at the Centennial Celebration for Business Education in the Baker Hotel, Dallas, Texas, in June 1957, Carl Salser, the then Editor-

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[1] Becker, *op.cit.*, pp. 9-11.
[2] Becker, *op. cit.*, p. 12.

in-Chief of Allied Publishers, Inc., pointed out that ours is the age of paper, and never before has so much depended upon its flow. He went on to say that "without machines that are wiser and faster than we in the handling of facts and figures, we may succumb to paper poisoning, before we awake!"

A Pennsylvania newspaper[1] gave a realistic conclusion of the situation in the final paragraphs of an article in this area:

> *"It's still the typewriters, adding machines, calculators that provide and prepare the raw data for input to the high speed computer. This raw data is still dependent on proper communications techniques, filing and storage facilities.*
>
> *"Once the electronic computer processes the data its findings must be distributed quickly—meaning copying and duplicating equipment, collators, sorters, various mailing equipment."*
>
> *There seems to be no end to the paper work in today's business life. Also, no end to the machines to handle the paper work.*
>
> *But the paper work could be a lot worse, the experts tell us, without the advances in the machines—including the latest electronic computers.*

The purpose of this chapter is to place emphasis on one of the major problems that is confronting business offices everywhere—paper, paper, and more paper. "Where should it be filed?" "I have so much paper work to do that I don't know where to begin." "How many copies should I make?" These are examples of expressions commonly heard in business offices today.

The avalanche of paper in some offices has become a critical problem. It is easy to say that communications such as letters and memorandums can be microfilmed, and material bearing statistics can be taken care of by data processing machines. The problem is deeper than this, and a concentrated effort is needed to analyze the total situation. Data processing is only part of the answer. Another solution might be fewer government reports, such as one rather than four social security reports a year. Also, consideration might be given to more industries discussing the standardization of forms in a manner similar to the way banks have standardized checks via MICR.

The ability to handle the increasing volume of paper work is one of the greatest challenges to business offices. Our present age has been referred to as the Technological Age, the Atomic Age, the Electronic Age, and the Nuclear Age. A more likely term could be the Paper Age. Small wonder that the business world has so many opportunities for youth with imagination, initiative, and the willingness to work long hours.

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[1] Editorial in *The Philadelphia Inquirer,* October 12, 1960.

CHAPTER SEVEN

Employment Opportunities

Data processing has been responsible for the birth of new job classifications, such as console operators and programmers, which are discussed in the first part of this chapter. Transcending the area to which this publication is addressed, those jobs that may be directly or indirectly affected by data processing are discussed in the second part.

Data Processing Jobs

There are three levels of work in data processing—professional, technical, and clerical. The professional level requires a four-year collegiate education or equivalent, the technical level requires six months to two years of post-high school education or equivalent, and the clerical level requires a high school education or equivalent. It is difficult to draw a line of demarcation to categorize each position in one of these three areas. Programmers, once regarded as professional employees, are now classified as technical.

Because of the large expense of renting or purchasing equipment, data processing installations frequently are operated 24 hours a day. Therefore, when personnel are hired men may be given preference for several reasons. First, men are more likely than women to remain in a position for a longer period of time after they have been trained for their job. Second, men because of family obligations are more willing to work at night. Third, labor laws in some states have a tendency to restrict the number of hours, as well as the time, women might work.

The *Dictionary of Occupational Titles* (D.O.T.) code numbers and information pertaining to some of the more common jobs found in data processing follow:

Key Punch Operator (D.O.T. 1-25.62). A key punch is a typewriter and ten-key adding-listing machine developed into one unit. It is operated by a key punch operator who, in using the touch system, converts data from various sources to a card approximately the size of a check. After reading the source document (sales slips, order forms, time cards, etc.) the key punch operator by depressing different keys converts the information into punched holes. In addition to the key punch, a key punch operator may operate a verifier, sorter, and other unit record equipment.

Irrespective of the existence of the scanning device, Optical Character Recognition (OCR), the need for key punch operators will exist indefinitely and some authorities predict that there will be a need for many more key punch operators in the future. Because of the illegible handwriting of many people, the use of OCR has its limitations.

Although a business may also use tapes, practically every computer system which processes business data utilizes punched cards. These are used increasingly for many purposes. One example is the new teleprocessing devices which transmit data over long distances.

Business pupils interested in this occupation should have a high degree of finger dexterity and know how to type. It is important that the right keys be pressed in the proper sequence so the ability to record letters and numbers without transposition is a prerequisite. Therefore, the recommended typewriting proficiency is 35 words per minute with no more than one error a minute on a five-minute test. A suggested minimum standard for key punch operators is 5,000 strokes per hour with 97 percent accuracy.

Peripheral Equipment Operator (D.O.T. 1-25.60 and 1-25.98). A peripheral equipment operator is referred to as an auxiliary machine operator, a card-tape converter operator, or a high-speed printer operator. The term "peripheral equipment" is giving way to the term "unit record equipment." Unit record equipment is discussed in Chapter IX.

With the possible exception of the key punch, a peripheral equipment operator runs all machines that prepare material for the computer. If machines do not function properly, he reports the problem to his supervisor.

In installations that have only unit record equipment or in cases where only unit record equipment is used, a peripheral equipment operator may be called upon to wire a control panel.

A peripheral equipment operator needs a general understanding of how the data processing system functions. As indicated, he should know how to wire a control panel. A peripheral equipment operator also should develop the ability to identify incorrectly punched cards or tapes, and recognize other situations that might prevent the proper operation of the system.

The specialized training of a peripheral equipment operator requires approximately six weeks. As in other data processing jobs, the more knowledge one has in accounting, algebra, business organization and management, and principles of data processing, the better are the opportunities of acquiring an initial job and of receiving an advancement to a position such as a console operator.

Console Operator (D.O.T. 1-25.17). A console operator is sometimes referred to as computer operator because his work is basically with the computer. In operating the console (central control unit) of the computer the console operator first studies the program instructions prepared for his use by the programmer. When the procedures to be followed have been determined, the console operator readies the equipment, checks the computer to see if it is loaded with the necessary input media (tape or cards), and starts the run. During the run he has control switches to operate and control panel lights to observe. The console operator tries to locate the source of trouble if the computer stops running or the lights signal an error. He keeps records of machine performance and production reports. Sometimes a console operator also operates the auxiliary equipment directly connected with the computer.

Because of the responsibility he has in operating a computer during a run, a console operator needs the ability to think rapidly and make quick decisions. The opportunities for advancement to the position of programmer are excellent for one who becomes a proficient console operator.

The console operator works with systems analysts and programmers, but he does not need the broad background required of these employees. However, it is most important that a console operator have an understanding of computers as well as unit record equipment. Also, he needs to know the fundamentals of programming. A knowledge of accounting, algebra, and business organization and management is necessary for advancement. It takes from two to six months of concentrated training for one to become a console operator.

Tape Librarian (D.O.T. 1-20.04). The basic responsibility of tape librarians is to maintain files of magnetic or punched paper tapes and issue them upon the request of console operators and peripheral equipment operators. A card for each tape is prepared that includes the following information: assigned number, date of tape preparation, and information on tape. These cards are often cross indexed.

A background in filing is needed by anyone who aspires to become a tape librarian. Accuracy and the ability to get along with others is most important.

Programmer (D.O.T. 0-69.981). As previously indicated, the work of a programmer is now considered a technical rather than a professional position. The job of a programmer is a challenging one because of the many facets of work in which he is engaged.

A programmer usually starts an assignment by discussing the nature of the work with others who furnish him with detailed information. For instance, in making up a payroll the programmer must know wage rates, overtime policy, hours worked, and deductions for social security and government bonds.

Next the programmer prepares complete and detailed instructions in the form of a flow chart and a block diagram. Usually instructions are translated by the programmer or coding clerk into a code—the machine language to which the computer responds.

The programmer's final responsibility is to double check (debug) the program by preparing and testing sample data.

In business data processing, a programmer needs a general knowledge of business organization and management and a specific background of the business in which he is working, such as banking or insurance. An understanding of accounting is a must since much of the work is involved with the accounting and auditing offices. In addition, a programmer needs some knowledge of algebra. Also, a thorough understanding of the machine functions and characteristics on which he is preparing a program is necessary and this includes an insight into both computers and unit record equipment.

With regard to the future need for programmers, new developments must be taken into consideration. Freed[1] in summarizing a speech made by Dr. M. Adele Schrag, Director, Department of Business Education, College of Education, Temple University, pointed out:

> *During the first years of automation it was thought that there would be a great need for programmers, but now new equipment has been designed that will take instructions in ink, and this can be converted into code that can be programmed by the machines. So programmers are not needed in the great numbers that was originally supposed. While some companies have increased their programmers, many are going into other systems and they predict a decreased need for programmers.*

Systems Analyst (D.O.T. 0-69.985). One of the most responsible positions in business data processing is that of systems analyst. Coordinating the work of the data processing department with other departments where present programs are evaluated periodically is one of the important duties of a systems analyst. As a result of these studies, procedures might be revamped and forms redesigned.

[1] Ruth Freed, "Automation in Business Education," *The New Jersey Business Education Observer,* 35:8, Fall, 1963.

Another responsibility of a systems analyst is to work with departments that are not using the facilities of the data processing department. Here, he would make a feasibility study or an analysis of present systems to determine the advisability of transferring some or all of the procedures to the data processing department. (Cost and time are the two factors most seriously considered.) Upon completion of the study, a recommendation is made to either transfer some or all of the procedures to the data processing department. If activities are transferred to the data processing department, the plans will be developed by the systems analyst.

The position of systems analyst is in the professional category, and a basic course in business administration on the college level is excellent preparation for this position. However, it is possible to become a systems analyst after working for a period of time as a programmer.

Miscellaneous Data Processing Jobs. The following are descriptions of additional jobs sometimes found in offices with large computer installations:[1]

> *Project Planner (D.O.T. 0-68.505). Plans and administers the installation of data-processing system.*
>
> *Coding Clerk (D.O.T. 1-36.05). Converts programmer's instructions into special machine "language" or code.*
>
> *Data Typist (D.O.T. 1-37.32). Operates electric typewriter equipped with special keyboard to transcribe coded program instructions or data on magnetic tape.*

Other Jobs

The jobs discussed in this part of the chapter have grown hand in glove with America's system of free competitive enterprise. Data processing may bring about changes in the type of work performed by persons in these jobs. However, the job classifications discussed in this part of the chapter will continue to play a significant role in the business world.

Bookkeeper. The work of the bookkeeper has been changing materially and data processing has made this more pronounced. Rather than make all of the transactions and prepare statements for one cycle, a bookkeeper might be responsible for one account such as "Accounts Receivable." The tendency has been for bookkeepers to specialize due to the growth of business in America.

The term "bookkeeper" is seldom used as a job classification. It has been replaced by the title "accounting clerk."

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[1] Automation and Employment Opportunities for Office Workers," Bulletin No. 1241 (Washington, D.C.: United States Government Printing Office, 1958), p. 5.

Secretaries, Stenographers, and Typists. The communications function of the office complements and supplements the work performed in the recording, retrieving, planning, scheduling, coordinating, and analyzing of data. This might be considered the "human side" of business activity and is the phase of work so very important from the public relations point of view.

Some years ago one of America's leading magazines[1] pointed this out in stating:

> *. . . what machine yet conceived can construct speeches for a man out of scraps he has written on the backs of envelopes, rebuild his ego when the front office has stepped on his neck, tell him when to take his thyroid pills, balance his checkbook, buy presents for his wife and tactfully get rid of an old acquaintance who keeps coming around for business advice?*
>
> *There'll always be a secretary.*

Three out of ten clerical jobs to be created in the next decade are in this area. For the most part there is a greater demand for secretaries, stenographers, and typists than for other clerical personnel. The number of positions for typists will increase less rapidly than that for secretaries and stenographers because of extensive use of copying and duplicating equipment.

Data processing will bring about limited change in these positions. Because of preparing information for, or in relationship to, data processing, secretaries, stenographers, and typists should have an understanding of principles of data processing. Also data processing should not have any effect on the number of clerical jobs that have a relationship to the public such as receptionists and complaint clerks.

Human Ability

As indicated in this publication, there are numerous opportunities for those who are interested in this area of work. As Jones[2] points out, the most critical need is *human ability*.

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[1] Elsie McCormick, "That Amazing Secretarial Shortage," *Reader's Digest*, 64:53, February, 1954.

[2] Adaline D. Jones, "Human Ability—the Great Need in Office Automation," *The Balance Sheet*, 43:203 and 240, January, 1962.

. . . The critical ingredient in automatic data processing is human ability—an ingredient disturbingly short in supply.

It seems almost a paradox that human ability should be of such importance in a process which is described as one in which there is a minimum of human intervention. Granted that automatic data processing does not take place without some sort of computer, the fact still remains that the computer is a lifeless, non-operating mass of metal, wires, tubes, transistors, diodes, memory cells, and switches until the human ingredient is added to the mix. No matter what its size, the computer must be told what to do, how to do it, when to start doing it, and even when to stop doing it. Furthermore, the computer can understand these instructions only when a very special language is used. People must supply these instructions in the language the computer can understand!

. . . .

CONCLUSION. The thesis of this article has been that human ability is the critical ingredient in an automatic data processing system. Since business educators are concerned with the development of human ability as it is needed in office occupations, business educators are faced with the challenge of developing people so that they may meet the demands of the new occupations on the labor market. Can we—WILL WE—as business educators accept this challenge?

CHAPTER EIGHT

Common Language Media

The office is frequently referred to as the nervous system of our modern business structure. It is the central location in which data (information) is recorded, classified, sorted, summarized, computed, and transmitted. The procedure for handling this information is data processing, which includes manual and mechanical means.

At the heart of the data processing system is an attempt to reduce the handling and rewriting of information so it can be processed more efficiently and effectively. To achieve this result, machines capable of understanding coded information are employed in the data processing system. The coded information to be used in communicating with data processing machines can be recorded on four media: paper tape, magnetic tape, magnetic ink characters, and punched cards. These are often called common language media in that they permit man to communicate with machines. A system incorporating one or more of these media is identified as an integrated data processing system as repetitive handling of data is eliminated.

An input device of the computer system is a machine specifically designed to sense or read information from one of the four recording media. In the reading process, recorded data are converted into a form that can be used by the machine to perform data processing operations. An output device is a machine that receives information from the computer system and records the information on one of the common language media. The number and type of input-output devices connected directly to the computer depend on the design of the system and its particular application.

Special data conversion equipment, which permits the transcribing of information recorded on one medium to another, is associated with all computer systems thereby giving each unit a range of flexibility. For example, information on punched cards can be transferred automatically to magnetic tape for use with a different system. Conversely, data on magnetic tape can be converted to punched cards.

Paper Tape

Punched paper tape is used both for entering data into a machine, input, and for recording or punching information from a machine, output. Data are recorded as an arrangement of punched holes, in specific locations on the paper tape. One advantage in using punched tape as an input device is that paper tape is a continuous medium which can be used to record data in records of any length, limited only by the capacity of the processing unit into which the data are to be placed or from which the data are received.

The two most widely used forms of punched paper tape are those containing five and eight channels to code numeric, alphabetic, and special characters. Figure 1 shows a section of an eight-channel and a five-channel paper tape illustrating the coding of alphabetic and numeric information, as well as special characters.

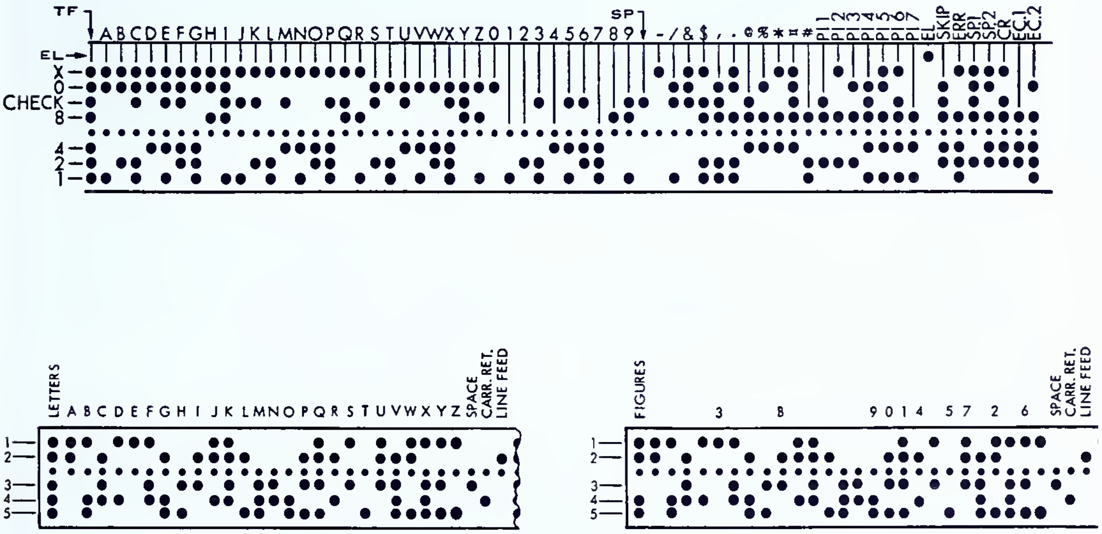

Figure 1. Eight-Channel and Five-Channel Paper Tape

Data are transcribed from source or original documents to paper tape by manually operated tape punching devices. Data punched in paper tape are interpreted by a paper tape reader and recorded by a paper tape punch. Figure 2 illustrates the Friden Flexowriter, an automatic writing machine, capable of writing a document automatically from either an eight-channel tape or standard IBM punched cards.

Figure 2. Flexowriter

Communication companies are among the largest users of punched paper tape.

Magnetic Tape

Magnetic tape is the most recently developed medium for recording information in a form that machines can process. It is the principal input-output medium used in the electronic data processing system which uses a high-speed computer to aid in the processing of data.

Several types of magnetic tapes are available to meet varying requirements of strength, durability, reliability, and cost. Magnetic tapes are either of metal or plastic and are coated with metallic oxide. Magnetized spots called bits record the data. The tapes are ½ to 3 inches in width and can store up to 800 characters per linear inch.

Information recorded on tape is permanent and can be retained for an indefinite period of time. Previous recordings can be destroyed when they are no longer needed by writing new information directly on top of the old, similar to the principle used in tape recorders. This feature permits repetitive use of the same tape with significant savings in recording costs.

Figure 3 illustrates a section of magnetic tape and the Seven-Bit Alphameric Code used to communicate with various electronic computers. Magnetic tape is used extensively in government installations, insurance and other large business operations.

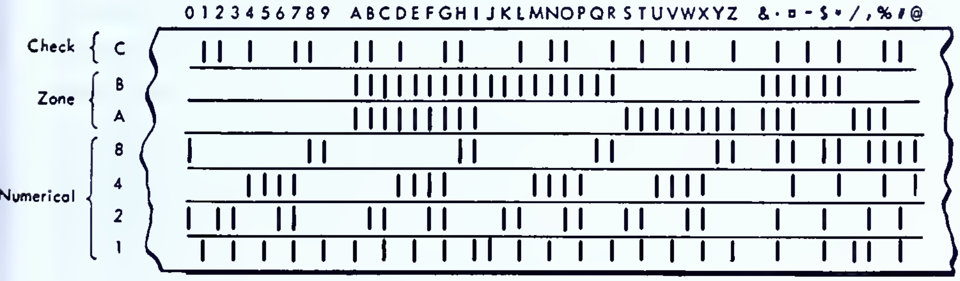

Figure 3. Magnetic Tape

Magnetic Ink Characters

Magnetic ink characters serve as the third medium of representing data in a machine-processible form. These characters are easily discernible by both man and machine. They are printed on paper as the ten Arabic numerals 0 to 9 and four special characters. See Figure 4. The shape of the characters permits visual interpretation by man; the special magnetic ink allows reading of interpretation by machine.

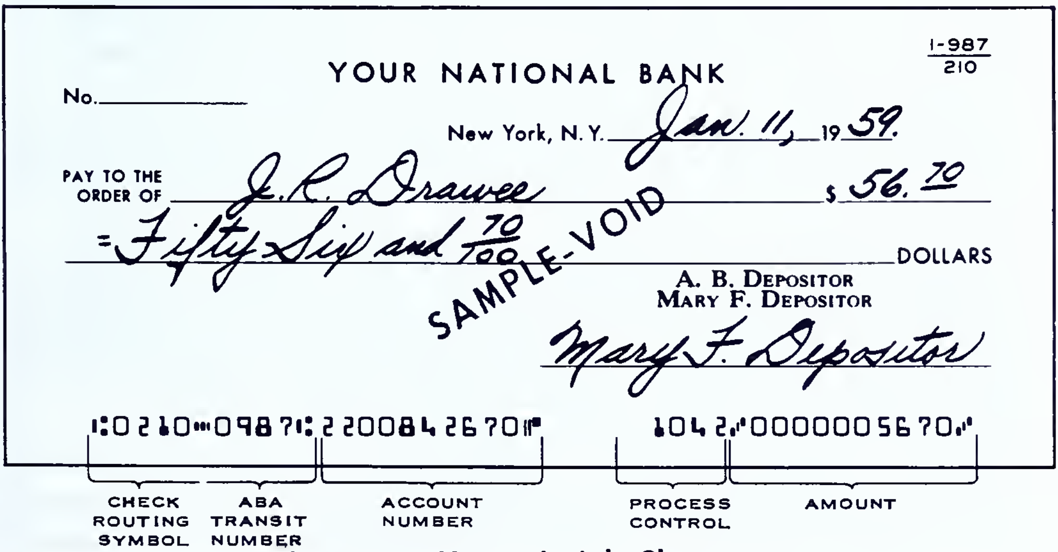

Figure 4. Magnetic Ink Characters

The printing and reading of magnetic ink characters on paper documents is accomplished by machines. The reading machines convert the inscribed data from the paper documents into a machine language which can be processed by electronic computers. The use of magnetic ink characters is used almost exclusively in the banking business.

In addition to the magnetic ink character readers, another data-input system is capable of reading characters printed on paper documents. Identified as optical character readers, these devices work with documents printed or typed in carbon inks by typewriters, high-speed output printers, or special imprinters. For instance, optical scanning machines are available which can read characters imprinted from credit cards and convert this information to punched cards or to magnetic tape for efficient machine processing. Along these same lines, the post office department has engaged in experimental work with optical character readers for use in sorting mail that has been addressed by such standard devices as typewriters, high-speed printers, and duplicating plates.

Punched Cards

The basic element in a data processing system is a punched card. It is one of the most widely used media through which man is able to communicate with machines. Information is recorded as small holes punched in specific locations in a standard size card measuring 7⅜ inches by 3¼ inches and .007 of an inch in thickness. The two major types of data recording punched cards have been developed by the IBM Corporation and UNIVAC Division of Sperry Rand Corporation. (UNIVAC is no longer a division of Remington Rand but is an independent and separate division of the parent company, Sperry Rand Corporation. Equipment formerly known as Remington Rand is now marked as UNIVAC equipment.)

Punched cards are used both for entering data into a machine and for recording or punching information from a machine. They serve not only as a means of transferring data from the original source, but also as a common medium for the exchange of information between machines.

Corner cuts, found on all punched cards, serve to call to an operator's attention any cards in the deck that are not properly placed (upside down or backwards). Card types also may be identified by the use of colored cards or the use of a colored stripe on cards of a similar nature.

Cards are divided into segments called fields. A field is a column or columns reserved for the punching of specific data. The field may consist of one column to eighty columns on an IBM card, or one to ninety

columns on the UNIVAC card, depending upon the length of the particular type of information which will be entered on the card. For example, a school having a total enrollment of 300 with no prospect of having more than 999 pupils would assign a three-column field to the recording of pupil numbers. If the school were expanding rapidly and anticipated an increase in enrollment to 1,000 or more, a four-digit field would be assigned. Another example is a date that requires six card columns; two columns for the month, two for the day, and two for the year.

Fields can be further identified by reference to the card column numbers in which they exist. An invoice number that occupies five positions could be located in card columns 1 through 5. A unit cost item that occupies four positions could be located in card columns 6 through 9.

Field assignment and general card layout should be made only after a comprehensive study of individual needs has been undertaken.

IBM Card. The IBM card provides eighty vertical areas called columns. They are numbered one to eighty from the left side of the card to the right. Each column is referred to as a card row and is divided into twelve punching positions. Information is represented on the card by the presence or absence of holes in specific locations, to indicate numeric, alphabetic, or special characters.

The twelve punching positions are divided into two areas, identified as numeric and zone. The first nine punching positions from the bottom edge of the card, referred to as the nine edge, are the numeric punching positions and have an assigned value of 9, 8, 7, 6, 5, 4, 3, 2, and 1, respectively. The 0 position is considered to be both a numeric and zone position. The remaining positions, 11 and 12, are the zone positions, and are located in the upper or twelve edge portion of the card.

The numeric characters 0 through 9 are represented by a single punch in a vertical column. For example, "5" is represented by a single punch in the 5 numeric position of the column.

The IBM card is not restricted to the recording of numeric information. The recording of alphabetic information can be accomplished by punching two holes in a single vertical column; one numeric punch and one zone punch. The alphabetic characters A through I use the 12 zone punch, also called the "R" punch, and a numeric punch 1 through 9, respectively. The alphabetic characters J through R use the 11 or "X" punch and a numeric punch 1 through 9. The alphabetic characters S through Z use the O punch and a numeric punch 2 through 9.

Figure 5 shows the actual punching of the IBM card for the recording of alphabetic information (letters), numeric information (digits), and special characters.

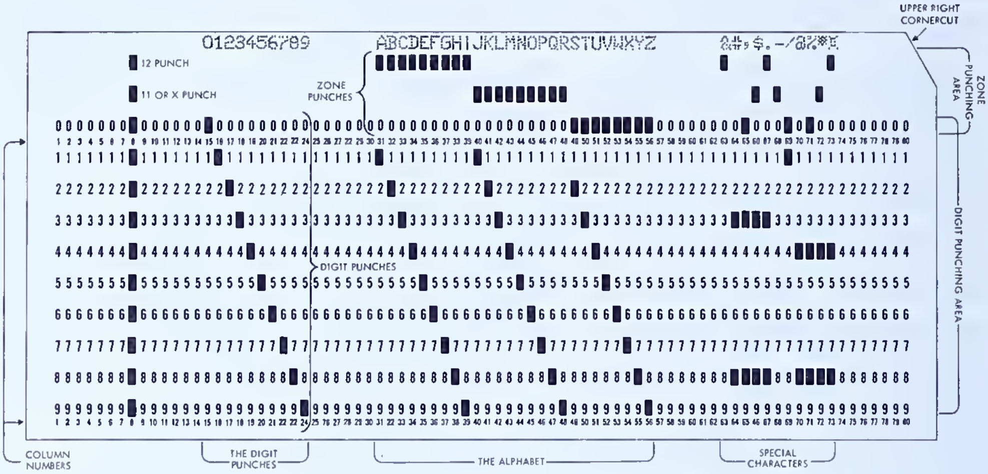

Figure 5. Punched Card (IBM)

Table I identifies the combination of punches for alphabetic information and the letter represented by each combination.

TABLE I

R or 12 punch in combination with	*X or 11 punch in combination with*	*0 punch in combination with*
1—A	1—J	
2—B	2—K	2—S
3—C	3—L	3—T
4—D	4—M	4—U
5—E	5—N	5—V
6—F	6—O	6—W
7—G	7—P	7—X
8—H	8—Q	8—Y
9—I	9—R	9—Z

UNIVAC Card. Figure 6, page 53, illustrates a 90 column UNIVAC card. The 90 columns are divided into 45 vertical columns in the upper half and 45 columns in the lower half. Each card has 540 positions, 6 positions for each column. In actual practice these positions are referred to as the 0, 1, 3, 5, 7, or 9 positions.

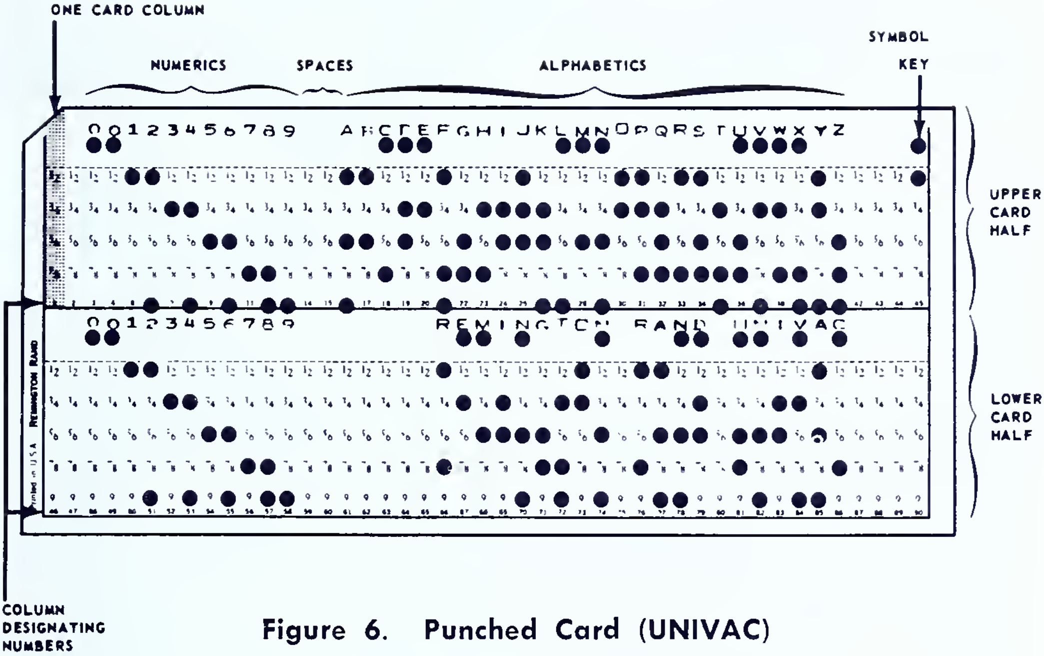

Figure 6. Punched Card (UNIVAC)

You will note that in each card column the punching positions are identified as 1_2, 3_4, 5_6, etc. The zero position is not usually printed. Zero, and odd number values (1, 3, 5, 7, 9) are expressed by single punchings in their respective positions. Even number values (2, 4, 6, 8) are expressed by punching the position for preceding odd number plus a 9 position. Thus, the 1 plus a 9 in the same column expresses a 2, a 3 plus a 9 expresses a 4, etc.

Alphabetic characters are expressed by a combination of two and three hole punching, so that it is possible to express the entire 26 letters of the alphabet and the ten numeric digits within the limits of the six punching positions provided in a single card column.

Table II illustrates the punching positions required to express each UNIVAC character.

TABLE II

Character	*Punching Positions*	*Character*	*Punching Positions*
0	0	I	3, 5
1	1	J	1, 3, 5
2	1, 9	K	3, 5, 9
3	3	L	0, 9
4	3, 9	M	0, 5
5	5	N	0, 5, 9
6	5, 9	O	1, 3
7	7	P	1, 3, 7
8	7, 9	Q	3, 5, 7
9	9	R	1, 7
A	1, 5, 9	S	1, 5, 7
B	1, 5	T	3, 7, 9
C	0, 7	U	0, 5, 7
D	0, 3, 5	V	0, 3, 9
E	0, 3	W	0, 3, 7
F	1, 7, 9	X	0, 7, 9
G	5, 7	Y	1, 3, 9
H	3, 7	Z	5, 7, 9

It is important to note, however, that the recording of any one of these twenty-six alphabetic or ten numeric digits is accomplished by only a single key depression. For example, the depression of the 8 key, automatically results in the punching of the 7 and 9 positions in a given column. Likewise, the depression of the S key results in the automatic punching of the 1, 5, and 7 positions of a given column.

From the above discussion, one might conclude that it is not important for the operator to understand the UNIVAC Coding System. This is not necessarily true. In actual practice, most operators easily memorize the numeric code pattern as this is helpful in the sight verification of punching. Very few operators attempt to memorize the alphabetic code and rely upon machine interpretation. (See page 61 for explanation of operation of the UNIVAC Interpreter.)

CHAPTER NINE

Unit Record Equipment

The basic raw material of the business office is information (data). Most office activities are directed toward changing this raw material into meaningful reports and records that management can use effectively as an aid in making decisions.

Mechanical devices and equipment are being used widely to handle information throughout a business establishment. This procedure is referred to as automatic data processing (ADP), and takes the form of a punched card system in most offices. A basic automatic data processing system can consist of only a key punch, sorter, and accounting machine. Complex systems are augmented by other types of punched card equipment including verifiers, interpreters, automatic punches, and collators. These machines will be discussed in the following sections.

Key Punches and Verifiers

One of the first steps in the data processing system is to convert the information from the source of original document into a form that can be understood and handled by machines. Chapter VIII discussed the significant role the punched card plays in this process. Punched card machines serve as the mechanical means for recording the original information on the punched cards.

IBM Key Punches (Card Punches). Several types of IBM machines are available for transcribing written data to holes punched into IBM cards. The two most commonly used are the IBM 024 Card Punch and the IBM 026 Printing Card Punch. These machines are identical with the exception of the printing device which is found on the 026. Figure 7, page 56, illustrates the 026. This device prints the numbers or letters at the top of the card as the punching takes place so that the information on the card can be read easily.

Punching is accomplished on either machine as a result of a punch die striking and cutting through the card at a given point. The set of 12 punch dies built into each key operated card-punch machine is internally connected to the keyboard and operates when the keys are depressed.

Figure 7. Card Punch

Key operated card-punch machines are equipped with one of three keyboards: numerical, combination numerical and alphabetic (three special characters), and combination numerical and alphabetic (eleven special characters).

On all keyboards, the punching keys are gray with blue lettering, and the control keys are blue with white lettering. The home keys are more concave than the other keys to facilitate accurate touch operation. The keyboard is of an interlocking variety so that no two keys can be pressed at the same time.

Combination keyboards combine the best features of a typewriter and a numerical keypunch. The letter keys are arranged according to the standard typewriter touch system. The digit keys are placed so that a rapid three-finger touch system can be used. Punching a digit or a letter with any of the combination keys depends on the shift of the keyboard. For example, the 6-L key punches a 6 when the keyboard is in numerical shift, but an L when in alphabetic shift. Shifting on the card punch machines is similar to upper or lower case shifting on a typewriter.

Unpunched cards (blanks) are placed in a card hopper which holds approximately 500 cards and is located at the upper right of the machine. The cards are placed in the hopper, face forward, with the nine-edge down. (IBM unit record equipment contains instructions indicating how the cards are to be fed into each machine.) The first two cards to be punched must be fed by pressing the card-feed key, while all other cards in the hopper can be fed automatically under the control of a switch.

As each card is punched by the operator, the punched out portion of the card automatically drops into a chip box and the card moves forward one column. Completed cards are automatically lifted into the card stacker at the upper left of the machine, in the order they were punched.

Each machine is equipped with a program unit which controls automatic skipping, duplicating, and shifting from numeric to alphabetic punching or alphabetic to numeric punching. This program unit operates on the same basic principle as the tabulator mechanism of a typewriter. Each programmed operation is designed by a specific code punched in a program card. The program card is locked around a program drum and inserted in the machine. The drum revolves, in step with the movement of the cards past the punching and reading stations, so that the program codes control the operations column by column.

IBM Verifiers. Accurately punched cards are essential to a record-keeping operation. As a result, after the holes have been punched in the card, the cards are usually verified. The machine used for this checking procedure is the IBM 056 Verifier. This machine is used to verify alphabetic, numerical, or special-character punching. The 056 is the same in appearance, features, and operation as the 024 and 026 card punch machines. The significant difference is that the verifier does not punch holes in the card, but rather checks the spaces in the card where the holes should appear.

In a data processing operation, after the cards have been punched by operator "A", the punched cards together with the original document, are turned over to operator "B" at the 056. Operator "B" inserts the punched cards into the verifier and, using the original documents as

copy, goes through the same procedure as if he were going to punch another deck. The verifying machine, instead of punching holes, merely searches for the punched hole in the cards from operator "A". If the operator of the verifier depresses the same keys as those which already have been punched in the card, the machine will notch the card at the right-hand edge as being correct.

If the verifier operator depresses a 4 key, for example, and the card contains a punch other than a 4 in that position, the machine will stop and show an error light. This error light indicates that operators "A" and "B" are not in agreement. At this time, the verifier operator has an opportunity to review the error. Three opportunities are available to the verifier operator to determine the accuracy of a punched hole. After these three checks, the 056 will place a notch over the card column in which the error has been found and permit the operator to continue with the verification of the next column. All cards containing errors are returned to operator "A" for correction, and then returned to operator "B" for reverification.

UNIVAC Key Punches (Card Punches). UNIVAC card punches contain 540 punch dies, one for each potential punching position in UNIVAC's 90 column card. As the keys on the UNIVAC card punch are actuated, the corresponding dies are partially depressed. When the data for an entire card have been recorded, a trip key is actuated, the punch dies descend, and all holes are punched simultaneously. This punch dies principle permits an operator to correct any detected errors prior to punching without spoiling a card or having to start the punching operation again. See Figure 8 for an illustration of the keyboard arrangement.

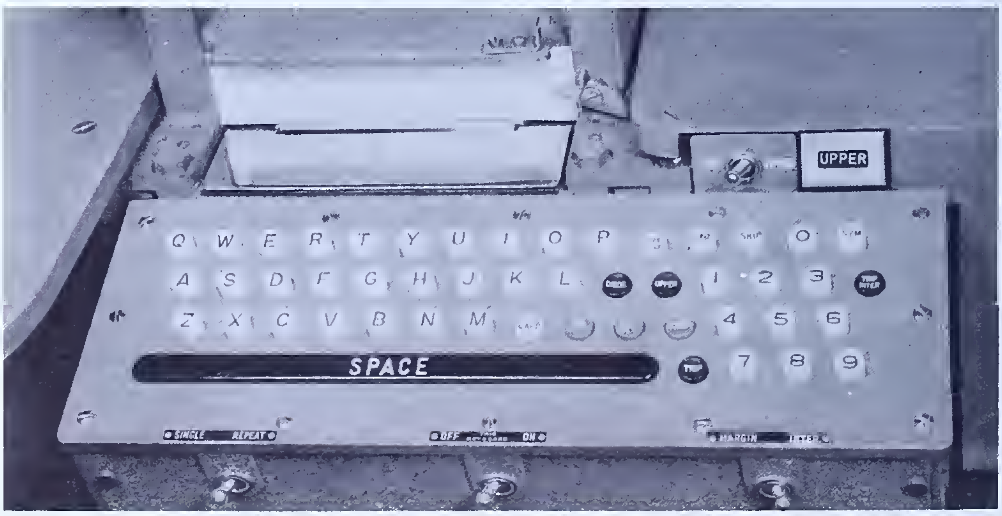

Figure 8. Card Punch Keyboard Arrangement

Constant information, common to a large group of cards, can be locked into the punch die mechanism and repeat punched into every card until the set-up is changed. Semi-variable information is key entered once and then punched into all succeeding cards until replaced by new key entries. Variable information is key entered for each card.

From a single key entry a number of identical cards can be gang punched at a speed of 90 cards per minute by the actuation of a repeat punch switch. The UNIVAC 306-2 Card Punch incorporates all the features described above. The UNIVAC 306-3 Card Punch is similar to the 306-2, and in addition contains card counting and serial numbering devices. The card counter provides the operator with a count of the number of cards that have been punched. The numbering device allows the printing of a serial identification number on all cards which have been punched.

UNIVAC card punches incorporate verifying attachments. The operation of this device will be discussed in the section on UNIVAC verifiers.

UNIVAC Verifiers. The UNIVAC verification method provides for the actual repunching of data into the card that was originally punched. This is in contrast to the method employed by the IBM 056 Verifier which does not punch holes, but verifies the accuracy of the holes that were originally punched.

After an operator has completed the punching of a group of cards from the source documents, the cards are turned over to another operator for verification. The operator actuates the verifying attachment on the UNIVAC Punch and proceeds to re-punch the data from the same source documents into the deck of cards that were punched by the original operator.

The holes punched during the verification operation are slightly below the original holes, resulting in an elongation of the original holes. Therefore, all the holes in an accurately punched and verified card would be elongated, or oval shaped. Any round holes would indicate inaccuracies in either punching or verification. Figure 9, page 60, illustrates a verified UNIVAC punched card. Note the error in this illustration.

Following the verification, the cards are passed through the UNIVAC 313 Automatic Verifying Machine. This machine, at a speed of 200 cards per minute, automatically identifies (flags) all cards that contain inaccuracies by interfiling blank colored cards behind any card that contains one or more round holes. The automatic verifier also punches a small hole in the right margin of every card as evidence that a card has been automatically verified.

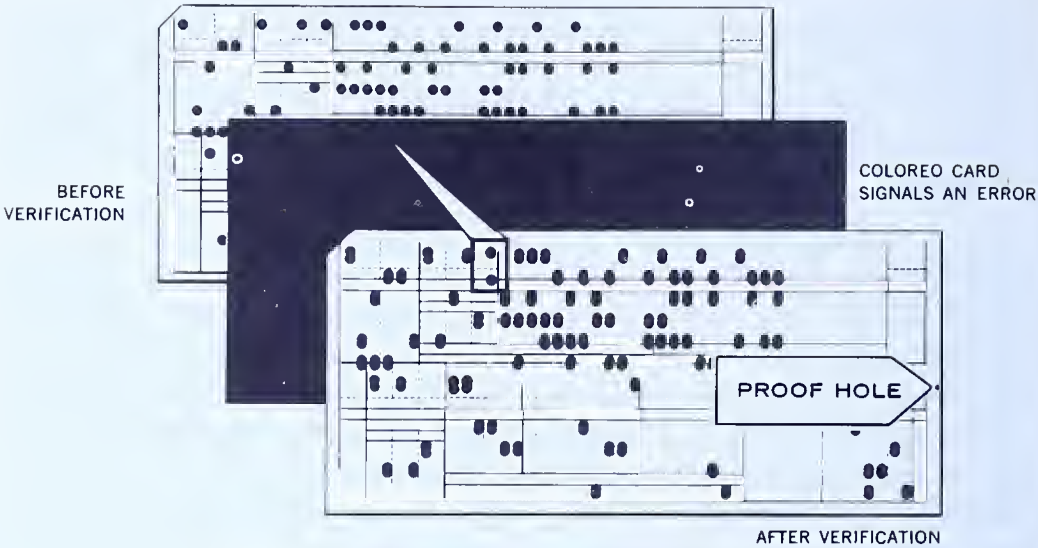

Figure 9. Verified Punched Card (UNIVAC)

Interpreters

In the typical data processing system, punched cards are used as original source documents rather than a secondary source of information in the automatic preparation of final reports. Depending on the type of business operation, various forms are designed on cards which serve as original source documents. The Federal Government, for instance, uses the 1040-A punched card as the formal income tax return for individuals with less than $10,000 total income. The Bureau of Motor Vehicles in the Pennsylvania Department of Revenue uses the punched card as a source document in the processing of car registrations. Other examples of the use of punched cards as source documents can be found in address cards, credit cards, payroll records, and checks.

To handle and process data which have been punched into cards effectively, the punched information should be translated into printed form on the card itself. This is true when the cards are to be handled by personnel unfamiliar with the punched card coding system discussed in Chapter VIII.

Not all machines are equipped with the necessary hardware that permits the printing of information as the card is being punched. Therefore, a need exists for the efficient reading of information punched in cards. The machines designed to read punched holes and print the desired information so the cards can be read with the same ease as typewritten records are called interpreters.

IBM Interpreters. IBM manufactures two machines capable of translating punched data into printed characters on a card. The models available include the IBM 548 and 557 Interpreters.

The IBM interpreters print information on one of two lines at the extreme top of the card face (the twelve edge). Upper line printing is along the top of the card above the 12-punch position, and lower line printing takes place between the 12- and 11-punch positions. The line on which the information is to be printed is determined by positioning a knob located in a recess at the back of the machine. An indicating marker shows which position is to be printed (U-Upper, L-Lower). The change must be made when the machine is not running, since the knob rotates while cards are being fed and the mechanism could be damaged easily. Data can be printed on the upper or lower line in any sequence, regardless of the order in which the information has been punched in the card. All information to be printed must have appeared initially in the card in the form of punched holes, or the data will not be printed.

The printing operation on the IBM interpreters is accomplished by directing the impulse received by the reading brush from the metal contact roller to the type bars. There are 80 brushes on these machines, one for each column of the card, which perform the reading function. The printing mechanism consists of 60 typebars. Each typebar contains 39 printing characters—10 numerical (0 through 9), 26 alphabetic (A to Z), and three special characters (when specified).

Because the IBM interpreters are designed to print a maximum of 60 characters on one line to facilitate ease of reading, the information printed at the top of the card is not in the same position as the holes in the punched field. Actually, the ratio of typebars (printing positions) is 60:80 or 3:4, since the 60 typebar positions print horizontally in an area covered by 80 columns. Thus, typebar 3 prints over column 4; typebar 6 prints over column 8; etc.

The 548 is designed to translate 60 columns of punched data into printed characters on each of two printing lines on the face of the card. To interpret more than 60 columns, the cards must be run through the machine a second time using the second printing line. The 548 is capable of interpreting 60 cards per minute.

The 557 performs the same functions as the 548 and has the added feature of being able to read information in a card and print that information at the rate of 100 cards per minute. In addition, the 557 is capable of printing as many as 25 lines of 60 characters on one card with a single pass through the machine.

UNIVAC Interpreters. UNIVAC interpreters are equipped with 45 printing wheels, each containing 36 characters (the numerals 0-9 and the letters A-Z). Data punched in the upper half of the card (45 columns) are interpreted in one pass at a speed of 90 cards per minute, and data punched in the lower half (45 columns) are interpreted in a second pass.

The interpreted data may be printed on any one of 13 different horizontal positions or levels of the card.

The data are printed directly above the card column containing the punching in most instances. However, the interpreted data may be rearranged if required. The printing of zeros is optional and printing may be suppressed in any column by the use of the printing lockout controls. This mechanism is located above the card feeding magazine at the front of the machine.

In the interpreting process, cards are first placed in the feeding magazine. From the feeding magazine, the cards move to a sensing section where the punched holes are read. The information thus read is then transmitted to the printing wheels. The cards move to the printing section where they are momentarily halted while the actual printing takes place. After printing, the cards are released into a card receiving pocket.

The UNIVAC 312 Interpreter incorporates the features described above and is designed to interpret data on the same card on which the data are punched. The UNIVAC 312-1 Posting Interpreter is similar in operation to the 312, but also has the capacity to sense the data punched in one card and print it on a succeeding unpunched card, or cards. A line finding posting device may be installed on the 312-1 which permits the sensing of data punched in a card and the printing of that data on the next open line of a succeeding unpunched card or cards. See Figure 10, page 63.

Sorters

In any data processing system, it is not enough to punch holes in cards, but rather the data must be grouped and arranged in proper order so as to facilitate the preparation of finished reports.

Manual sorting and arrangement of data into numerical or alphabetic sequence has been a time-consuming and tedious procedure. The biggest problem stems from the fact that the handling of large numbers of documents often results in costly mistakes due to human error. To help alleviate this difficulty, specialized machines capable of arranging punched cards in a desired sequence have been developed. This sorting process is accomplished with mechanical equipment called sorters. These sorting machines can select cards on an alphabetic or a numeric basis. Machines of different styles and speeds to meet varying requirements are available. Sorter speeds range from 250 to 2,000 cards per minute. Sorting time can be determined by multiplying the number of cards to be sorted by the number of columns in which control information is contained and dividing the result by the sorter's rate of speed. For instance, it

Figure 10. Interpreter

would take 64 minutes to sort 4,000 cards on 4 columns on a sorter that operates at the rate of 250 cards per minute: $4{,}000 \times 4 = 16{,}000 \div 250 = 64$ minutes.

IBM Sorters. The IBM sorters most commonly used are:

Type	*Operating Speed (Cards per minute)*
082 Series 50	450
082 Model 1	650
083	1,000
084	2,000

Each of the sorters is the same in appearance, features, and operation. The basic difference is that the 084 uses a photoelectric principle to sense punched information in cards which results in a higher operating speed.

The actual sorting operation on an IBM machine, except the 084, is controlled by a sorting brush which is located in the upper right hand section of the sorter. See Figure 11. This sorting brush can be set on any column by turning the selection handle that is located on the front of the machine near the hopper. Each turn of the handle moves the brush one column. A column-indicator guide and pointer are located above the brush assembly for convenient setting of the brush on any one of the 80 card columns. Only one column can be read at a time by the sorting brush.

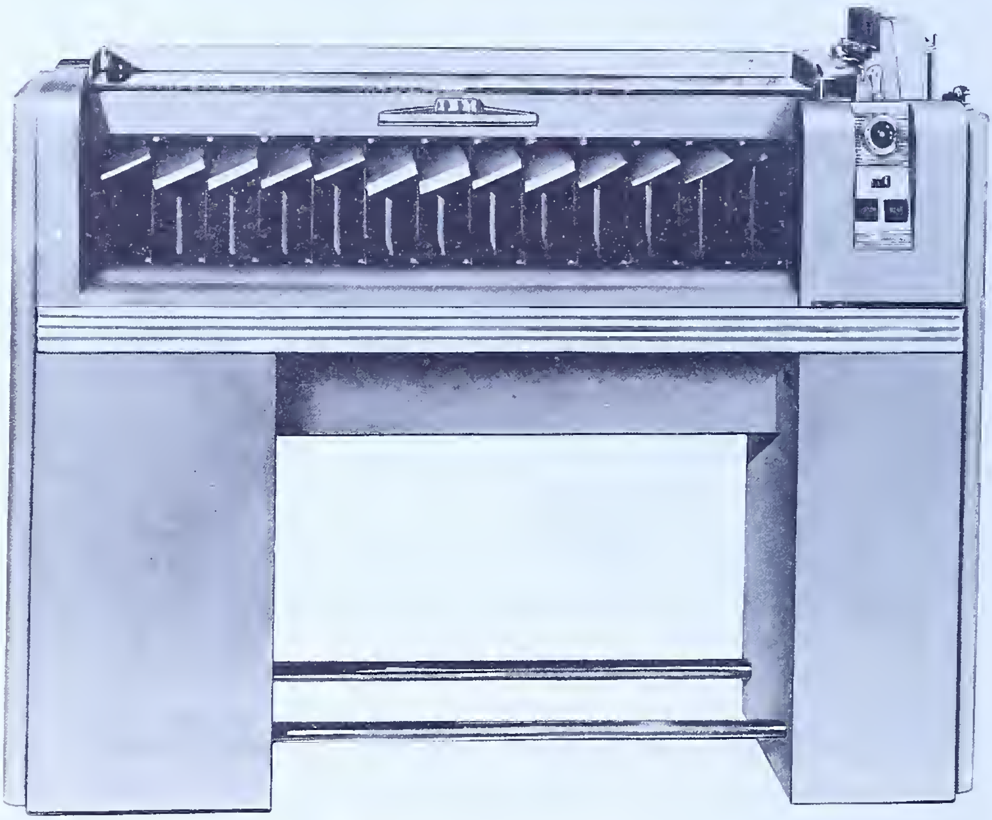

Figure 11. Sorter

When the start key is depressed, the cards are automatically fed from the bottom of the stack and advance between the sorter brush and an electrically charged metal contact roller. As the brush drops through the first punched hole in the column, contact is made with the metal roller to complete an electrical circuit. A chute blade corresponding to the punched hole is magnetically opened, and the card is directed by the chute and feed rollers into the proper pocket.

Each sorter is equipped with 13 receiving pockets arranged from left to right: 9, 8, 7, 6, 5, 4, 3, 2, 1, 0, 11, 12, and R. Each pocket corresponds to one of the 12 punching positions in a card column. The R (reject) pocket receives cards that are unpunched in the column being sorted, or cards that are treated as blanks according to the setting of the selection switches.

The selection switches permit the separation from a file of all cards containing a specified punch, without disturbing the sequence of the remainder of the file. The selected cards fall into their respective pockets and the remaining cards fall into the reject pocket.

In normal operation, all switches are set in the outer position for sorting on punches 9 through 1. When only cards with certain punches are to be selected, it is necessary to pull toward the center all the selection switches except those corresponding to the punches to be selected. All other cards are treated as blanks and thereby rejected.

Setting the alphabetic sorting switch toward the center has the same effect as pulling all the numeric punches 9—1, toward the center, which permits sorting only the 0, 11, and 12 punches since all other punches are ignored.

To arrange cards in numerical order, each column in the field requires only one sort. Sorting progresses column by column, from right to left, across the field. For example, when cards are to be sorted by an employee number which is punched in columns 8 and 9, the right hand or units position would be sorted first. In other words, the selection handle would be turned first to column 9 and the start key depressed. To complete the numerical arrangement, the sort brush would be set on column 8 by turning the selection handle to the left, and the cards would be sorted a second time. This sort would place the cards in ascending order from employee number 01 to employee number 99. This same procedure would have to be repeated for the third and subsequent columns when sorting larger fields of information.

Since the letters of the alphabet are composed of two punches in each column, alphabetic sorting requires two sorts on each column. The cards are first sorted on the numerical portions of the letters to group them by the digits 1 through 9, and then sorted on the zone portion by moving the alphabetic sorting switch toward the center. This setting of the alphabetic switch cuts out the normal circuits 1 through 9, and only permits the sorting of zone punches. As a result, all cards will fall into the 12, 11, or 0 pockets. The 12 pocket will contain all cards punched with the letters A through I, the 11 pocket those with the letters J through R, and the 0 pocket those with S through Z, all arranged in proper alphabetic sequence.

UNIVAC Sorters. UNIVAC provides three sorters capable of automatically arranging cards in any predetermined numerical or alphabetical sequence of the punched data. The sorters are the UNIVAC 320 Automatic Sorter, the 420 Electronic Sorter, and the 421 Electronic Counting Sorter. The most widely used model is the 420. This machine sorts 90-column tabulating cards at a speed of 800 cards per minute. The electronic sorter uses the photoelectric principle to sense punched information in the cards. This is similar to the electric-eye principle used to open and close doors in many banks, supermarkets, and theaters.

A beam of light making contact with an electronic tube determines which card receiver will be instructed to accept the card. As the card moves under this sensing selector, beams of light move over the card and shine through the punched holes in the card which completes the circuit. As the circuit is completed, the card is channeled into one of the 14 pockets into which the cards may be sorted. The fourteenth pocket (Reject) receives cards that are unpunched in the column being sorted, similar to the operation on the IBM sorter.

The following table outlines the numbers and letters which will be sorted into each of the pockets, starting with pocket 1 at the extreme right-hand side of the sorter and ending with pocket 14 at the extreme left-hand side of the machine.

Pocket	*Letter or Number*	*Pocket*	*Letter or Number*
1	A or N	8	H, U, or 4
2	B or O	9	I, V, or 5
3	C or P	10	J, V, or 6
4	D, Q, or O	11	K, Y, or 7
5	E, R, or 1	12	L, Y, or 8
6	F, S, or 2	13	M, Z, or 9
7	G, T, or 3	14	Reject

The 420 is equipped with automatic stop controls which operate when one of the card receivers becomes full, or when the feeding magazine becomes empty.

Actual sorting is accomplished by the setting of an index wheel, located on the right side of the control panel box, which directs the photoelectric sensing selector to the column which is to be sorted. As a card enters from the feeding magazine, it passes under the photoelectric sensing selector where it is scanned for punches in that column. At this point, a selection is made and the card is permitted to continue through the machine. When the card comes to within ⅝ inch of its appropriate card receiver, the card gate for that receiver opens and directs the card into the pocket.

All electronic sorters are equipped with a control panel which permits numerical or alphabetical sorting. The lower portion of this control panel contains three code selection keys: key 0-9 which sets the machine for numerical sorting: key A-M which sets the machine for sorting the first half of the alphabet, and key N-Z which is used to sort the last half of the alphabet. Other selection keys included on the control panel are a clear key, a power indicator light, a column indicator scale, a starter key, a stop key, and a power switch which turns on the current for the sorter to operate.

Flexibility for handling special sorting problems is provided by means of a connection panel located below the control panel on the right front of the machine. This connection panel contains sockets into which connection wires can be placed to establish the sensing, selecting, and receiving connections desired for the particular type of sorting to be performed.

Automatic Punches

It is often found that information contained on one document is needed at another state of the data processing system, and needs to be duplicated for handling by different departments. Furthermore, changes on original records must be made continually to keep records up to date. Rather than having to duplicate and reproduce information of this type manually, the punched card can be used in conjunction with a mechanical process that eliminates much of the work involved in these repetitious operations. This mechanical process of rapidly transferring information to punched cards is accomplished automatically by machines known as automatic punches or reproducers.

Automatic punches

1. produce an identical deck of punched cards from a deck that has been punched;
2. produce a second deck of cards containing selected portions of information from a prepunched deck of cards;
3. read information from a master card and transfer or punch this information into each succeeding card requiring the same data; and
4. compare the punches in two decks of cards and signal when the decks are at variance with one another.

IBM Automatic Punches. Some or all of the functions identified above are performed by the three types of IBM automatic punches:

1. Reproducing Punches (two feeds) IBM 514, 519, 528, and 549 are designed primarily to copy, or reproduce, original files so that the

duplicate can be used for diverse operations without disturbing the original file.

2. Summary Punches (one feed) IBM 523, 524, and 526 are designed primarily to punch tabulated information from accounting machines into total or new balance cards.

3. Card Read Punches (one feed) IBM 521, and 529 are designed primarily as the input-output units for calculating systems.

The most widely used IBM automatic punch is the 514 Reproducing Punch Machine. See Figure 12. This machine is capable of performing each of the four principal functions of automatic punches mentioned previously. The 514 also is capable of performing two other selected operations. It can be connected to an IBM accounting machine by means of a summary punch cable so that data being printed on a final report also can be punched into a blank card. This process is known as summary punching. For example, when a payroll report is being prepared on an accounting machine, the report can be set up to show for each employee, old year-to-date earnings, current weekly salary, total deductions, and new year-to-date earnings. As these totals are printed for each employee, the information can be automatically punched into summary cards by the summary punching circuits in the reproducing punch. These summary reports can then be used for the preparation of the payroll report for the following month.

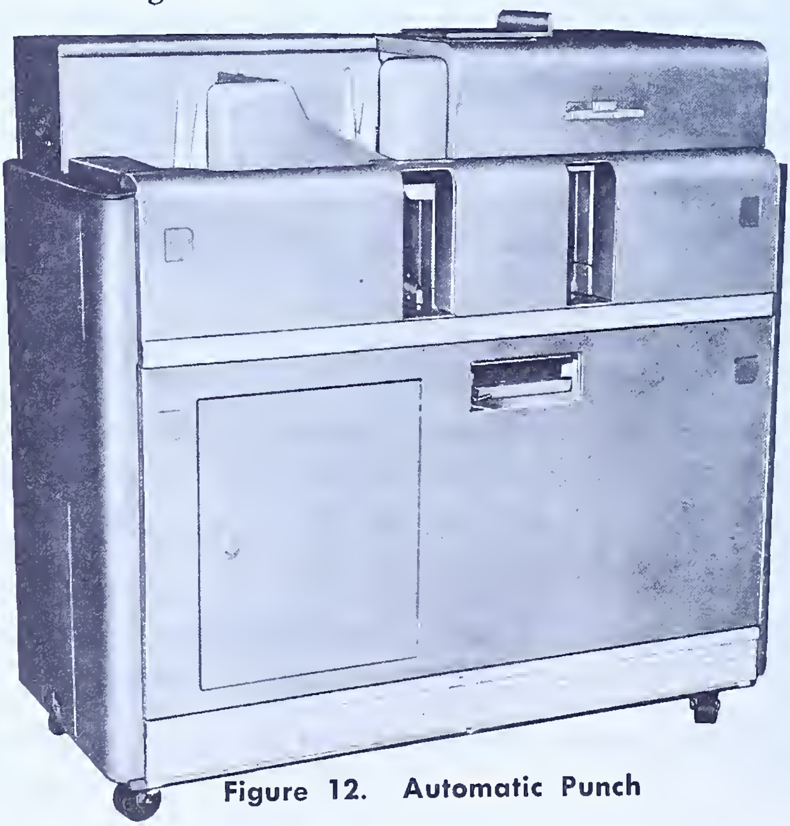

Figure 12. Automatic Punch

The 514 also can convert mark sensing into punches. In this operation, information recorded in the form of electrographic pencil marks on IBM cards, similar to the procedure used in connection with test-scoring machines, is automatically transcribed into punched holes in a deck of blank cards. The reproducing punch is not generally equipped with this mark sensing feature. If the business office is the type of installation which processes its information by means of the mark-sensing process, the basic reproducing punch can easily be equipped with this feature.

All functions on the 514 are performed at the rate of 100 cards per minute, regardless of the number of columns being punched. This mechanical process saves considerable amounts of time whenever records need to be reproduced.

While a prepunched deck of cards is being reproduced, a comparison can be made to determine if the newly punched card is identical to the prepunched card which has been read. Any variance in the comparison operation causes the machine to stop and indicate a disagreement in the two cards. These same two cards would then have to be manually checked and possibly repunched to correct the discrepancy.

All cards are fed into the IBM 514 with the upper portion of the card (twelve edge) leading. The prepunched cards are placed in the read unit feed hopper at the left of the machine, while the blank or unpunched cards are placed in the punch unit feed at the right. In the normal reproducing operation, one unit of the machine reads previously punched cards while the other unit punches the blank cards that are to become copies of the original. Since the two card files (original and copy) are to remain separate, the reproducing punch also has two stackers that receive the cards; one for the cards processed by the read unit and the other one for the cards that have been punched by the punch unit.

UNIVAC Automatic Punches. UNIVAC manufactures several machines which either automatically create punched cards or reproduce data from one punched card into another.

The UNIVAC 314 Reproducer has two feeding magazines and will automatically reproduce punched data from punched cards into blank cards at a speed of 125 cards per minute. It will create (gang punch) a multiple number of identical punched cards from a single pre-punched card. These reproductions may be partial or complete. Card counting and numbering devices also are available.

In addition to performing all of the functions of the 314, the UNIVAC 310 Multi-Control Reproducer will transfer data from one deck of punched cards to another under what is referred to as controlled conditions. For instance, a deck of punched cards containing employee number

and name could be placed in the upper magazine and a deck containing only employee number could be placed in the lower magazine. The multi-control reproducer would simultaneously feed cards from each magazine, and reproduce the employee name from the upper to the lower card when it matches the employee number on the card in the lower magazine. There may be cards in the upper magazine for which there are no matching cards in the lower magazine. Also, there may be identical cards in the lower magazine and only a single matching card in the upper magazine. Unmatched cards would be directed to a special receiving magazine.

The UNIVAC 315 Collating Reproducer is the same in features and functions as the 310. In addition, it has the ability to collate (merge) the upper and lower card decks. The 315 can concurrently punch and collate, punch only, or collate without punching. This reproducer can segregate cards that are not collated, and verify the sequential arrangement.

Oftentimes the UNIVAC 311 Summary Punch is physically attached to the UNIVAC Model 3 Tabulator. Concurrent with the printing of totals and grand totals by the tabulator, the 311 will automatically punch summary cards containing designated information and amounts. The summary punching operation does not reduce the speed of the tabulator and the summary card may contain all, or only selected portions, of the data printed by the tabulator.

The UNIVAC 5440 Optical Scanning Punch photoelectrically reads pencil marked data from the face of an optical scan card and automatically punches this data into the same card at a speed of 150 cards per minute.

Collators

One of the major problems confronting most business offices today is the filing and maintenance of accurate, up-to-date, and accessible records. It is often found in business report preparation, that data which have been accumulated in two or more departments must be combined for the summarization of the total financial activities of the firm. Manual procedures for compiling these summarized developments are extremely costly and time consuming.

The widespread use of punched cards has not alleviated the difficulty entirely, but it has brought the matter under control. As unit records themselves, punched cards serve as a means of reporting each and every business event on a separate document. Their particular usefulness stems from the fact that they can be transported easily and arranged in any desired sequence. Without equipment, the arrangement and rearrange-

ment of punched cards would prove to be a formidable task. This burden of the business office has been lightened by the development of mechanical equipment capable of combining (merging) business transactions in an attempt to facilitate report preparation. Collators are the mechanical filing machines that arrange punched cards according to a pre-determined pattern for subsequent processing.

Collators are capable of performing four basic functions—matching, merging, selecting, and sequence checking. The collator can also match-merge by performing the two functions simultaneously.

Matching is the operation in which two files (decks) of cards are compared to determine whether there is a card or group of cards in the one file that corresponds to a card or group of cards in the other file. The result of the process is that corresponding or matched cards are stacked separately, side-by-side, while unmatched cards in either or both files are removed from the stacks. At the completion of the operation, there may be up to four groups of cards; two groups that match and two groups of selected unmatched cards. Matching differs from merging in that matched cards from data files are stacked in two groups rather than in one combined group.

Merging is the process in which two files of cards, in numerical sequence, are combined to produce one complete file in numerical sequence. The cards to be merged are generally arranged in ascending order and as a result, the merged file is in ascending order. Merging can be performed in combination with both selecting and sequence checking.

Selecting describes the withdrawal of any card or cards from a file according to predetermined conditions. The conditions are controlled by wiring the control panel. Examples of selecting operations include

1. the first of each group of cards punched with the same control number;
2. the last of each group of cards punched with the same control number;
3. single cards not part of any given group;
4. all cards with a given number; and
5. cards punched with numbers between an upper or lower limit (1240 to 3599 for example).

Sequence checking is the process of verifying the ascending order of a file of cards. Most collators are also equipped to verify the descending order of a file of cards, although this is not ordinarily done. Whenever an error in sequence is detected, card feeding is automatically stopped and an error light flashes. Actually, each card is merely being compared with

the previous card and the lower of the two is directed to one of the receiving pockets.

In the match-merge process, two files of cards are compared to determine whether there is a corresponding card or group of cards in each file, and the matched cards are combined to produce one complete file in matched, numerical sequence. All unmatched cards in either or both files would be removed from the stacks. There may be three groups of cards at the completion of the operation—one merged deck and two groups of selected unmatched cards

IBM Collators. IBM collators can be divided into groups: numerical—IBM 085 and 088, and alphabetic—IBM 087 and 089. The 085 compares and files two groups of cards according to the numerical information punched in the cards. See Figure 13. This machine can process from 240 to

Figure 13. Collator

480 cards per minute, with both feeds in operation. In collating on the 085 and the 088, cards in both feeds can be checked for blank columns separately or in combination with other operations. Whenever a blank occurs in a field wired to the detection units, card feeding stops and a blank-column detection light goes on. This feature is especially useful as a checking device to see that all columns desired have been punched. Another point of difference on the 088 is that each of its two feeds can operate at a speed of 650 cards per minute. With both feeds in use, up to 1300 cards can be processed in one operation.

The main differences between the 085 and the two alphabetic collators (087 and 089) lie in the fact that the alphabetic collators are capable of processing letters as well as numbers. In addition to handling alphabetic characters, the 087 and the 089 can sequence check, match, merge, or select special characters, blanks, and numerical information in a card.

Each IBM collator is equipped with two card feed magazines. It is through these feed units that punched cards are fed into the machine. The lower of the two units in terms of position on the machine is identified as the primary feed hopper. The main file of cards is placed in this unit. Cards to be merged with the main file are placed in the upper magazine, called the secondary feed hopper.

Cards are placed in the hoppers face down, with the nine-edge leading. Each holds approximately 800 cards and is equipped with an automatic-stop contact, which restricts feeding when too many cards have been placed in the feed units. As soon as the last card is fed from either hopper, the collator will automatically stop.

The two feed hoppers are equipped with at least one set of 80 brushes capable of reading all of the columns on each card simultaneously. In the sensing operation a comparison is made to determine the relative worth of each card (which is of a higher numerical value). This comparison determines whether (a) the data punched in the card from the primary feed is lower than the data punched in the card from the secondary feed, (b) the data punched in the card from the primary feed is higher than the data punched in the card from the secondary feed, or (c) the data punched in the card from the primary feed is identical to the data punched in the card from the secondary feed.

The cards are channeled into one of four receiving magazines located at the left front of the machine. These pockets or stackers hold approximately 1,000 cards and are equipped with a lever to stop the machine when a pocket is full. The four pockets are numbered from right to left, 1 to 4. Stacker 1, called the selected primaries stacker, will accept cards that have been selected from the primary feed hopper. The second

stacker, called the merged cards stacker, normally accepts cards from both the primary and secondary feed hoppers and merges the two decks into one file. Stackers 3 and 4, identified as the selected secondary stackers, will accept cards from the secondary feed only. Accordingly, pocket 1 is for selected primary cards, 2 for merged cards, 3 and 4 are for selected secondary cards. Primary cards can stack in either pockets 1 and 2. Secondary cards can stack in pockets 2, 3, or 4. Merged cards will always stack in pocket 2.

UNIVAC Collators. The UNIVAC 315 Collating Reproducer, discussed previously, and the UNIVAC 319-1 High-Speed Collator are the two most widely used UNIVAC collators. Both machines are capable of sequence checking, selecting, merging, and/or matching any desired card or group of cards. The 315 operates at a speed of 100 cards per minute from each of two feeding magazines, providing a total card-feeding speed of 200 cards per minute. The 319-1 is capable of processing both alphabetic and numeric information, at a speed of from 250 to 500 cards per minute, when its two feeds are being fed simultaneously.

The UNIVAC collators are controlled by wired interchangeable connection panels which can be wired to handle each particular application. These machines compare 30 columns of data from one source with 30 columns from another source to determine: (1) which has the higher number, (2) which has the lower number, and (3) which are numerically the same. This comparison may be between one file, between the cards of two files, between separate fields of the same card, between cards and information that can be stored in the machine, or combinations of each of these operations.

Each collator is equipped with two feeding stations, each of which contains two reading stations. The main file of cards is placed in the primary feed, while the cards to be merged with the main file are placed in the secondary feed. As the cards are fed to the reading or sensing stations, a comparison is made and the cards are directed to one of the four card receivers according to the instructions wired in the connection panel. The four card receivers or pockets are numbered from right to left, 1 to 4. Cards from the primary feed may be directed into one of three pockets: pocket 1, labeled selected primary; pocket 2, labeled separated primary; and pocket 3, labeled interfield primary-secondary. Cards from the secondary feed can be directed into one of two pockets—pocket 3 or 4 labeled selected secondary. Pocket 1 will accept cards that have been selected from the primary feed unit, while pocket 4 will accept only cards selected from the secondary feed. In a merging operation, both primary and secondary cards will be directed into pocket 2 and interfiled into one deck, in either ascending or descending order. In a single

file operation, all primary cards not selected into pocket 1 will be directed into pocket 2. In a two-file matching operation, the primary cards which match the cards in the secondary feed will be directed to this pocket. Cards from the secondary feed which match those contained in the primary feed will be directed to pocket 3.

The UNIVAC High-Speed Collator is capable of simultaneously checking one or two files of cards which have been placed in either the primary feed and/or the secondary feed. Concurrent with a collating operation, the sequence of each deck of cards is automatically checked. Files can be checked on the basis of ascending or descending order. If a card in either deck is detected to be out of sequence with the rest of the file, a signal light flashes identifying the discrepancy. The card out of sequence would then be manually sorted into its proper position and the rest of the file processed by depressing the start key.

Accounting Machines

Studies of business organization failures indicate evidence of weaknesses such as insufficient working capital, overextension of credit, overinvestment in inventory, excessive debt, and large withdrawals of profit. There generally are several facets to each case of failure, and many can be traced to a general lack of intelligent planning on the part of management. In comparison, a significant characteristic of the efficient, successful business operation is one in which management is informed by means of reports dealing with inventory, payroll, production, sales, and various other elements of the business activity.

The basic purposes of accounting machines are to print alphabetic and numerical data punched from cards in an orderly and meaningful way and to total data by proper classification.

Functions. Each accounting machine can be set up to perform the following functions:

Detail Printing—This is the process of printing information from each card as it passes through the machine. Information can be selectively printed or printed anywhere on the report form according to control-panel wiring which directs the machine.

Accumulating—Amounts punched in cards can be added or subtracted selectively, according to control-panel wiring, to give a cross-foot total for a single card, or a grand total for successive cards in a group.

Group Printing—In this operation, often identified as tabulating, information on each card is automatically accumulated, but not printed. The only printed information is the pertinent data sufficient to identify the group of cards and the totals for each group of cards.

Programming—This is the function by which the accounting machine distinguishes the cards of one group from those of another so that individual group totals can be printed. There are three classifications of program control: major, intermediate, and minor. For example, if automatic totals are desired for states, counties, and cities, state is the major group, county is the intermediate group, and city is the minor group. Programming is accomplished through control-panel wiring.

Summary Punching—Summary information processed on the accounting machine is transmitted to a summary punch in the form of punched holes. This process is controlled by the control panel in the accounting machines, as well as by the control panel in the summary punch.

IBM Accounting Machines. The IBM accounting principle consists of three basic steps:

1. Information written on source documents is transcribed to punched cards.
2. Punched cards are arranged by a sorter in the sequence desired.
3. Printed reports are prepared automatically by accounting machines that read holes in the cards and print the reports.

The IBM machines capable of reading the holes in cards and automatically preparing printed reports are the 402, 403, 407, and 419 Accounting Machines.

The 402 and 403 are similar in operation and function. They differ only in the number of lines that can be printed from one card. The 402 prints one line from a card, while the 403 is equipped to print three lines from a card. This feature is identified as multiple-line print (MLP). The 419 is identical to the 402 except that the 402 can print both alphabetical and numerical information while the 419 is limited to printing numerical information.

In other respects, these three machines are alike, and the same basic principles of operation apply to each. The printing unit on these machines consists of a variable number of type bars, depending upon the model of the machine and the report requirements of the particular company. The maximum number of type bars is 88, of which 43 print both alphabetic and numerical information, while the other 45 print only numerical information. The 43 combination, alphabetic and numerical type bars, referred to as alphamerical, are located on the left side of the print unit, and the 45 numerical type bars can be found on the right

side. A ribbon guide, equivalent to one type bar space, separates the two distinct sets of type bars. Since the 419 does not have a ribbon guide, it features 89 numerical type bars.

Each alphamerical type bar consists of the 26 alphabetic characters, the numbers 0-9, and a special character position that normally contains an ampersand (&). Each numerical type bar consists of the numerals 0-9 and one symbol. In an odd-numbered typebar, this symbol is an asterisk (*), while a credit symbol (CR) is found in the even-numbered type bars.

In the actual printing operation on these machines, the character in the type bar to be positioned for printing is determined by the holes punched in the card, or by the totals which have been automatically accumulated in the machine. Located behind each type bar is a small hammer that is released after the type bar has been positioned, thereby forcing the type bar character against the paper and causing printing to take place.

Printing on the 407 is accomplished by the use of print wheels. This machine contains 120 print wheels, each containing 47 characters. The 47 characters are the digits 0-9, the letters A-Z, and 11 special characters.

The 120 print wheels are arranged in a solid bank and print within a width of 12 inches, 10 characters to the inch. In the printing operation, the print wheels are moved forward against the platen in a straight-line motion, as opposed to the 402, 403, and 419 machines, which operate by having the hammer drive the type bars against the platen. The 407 is also a multiple-line printing machine in that it can print up to three lines from a single card.

The four IBM accounting machines operate at various rates of speed, ranging from 50 cards per minute on a 402 model to 150 cards per minute on the 407. Speeds are identified as 50/50, 80/80, 80/150, 100/150, and 150/150. This means that the machine will detail print at the rate of the first figure presented, and group print at the rate of the second figure presented. For instance, in the first case, this machine will detail print at the rate of 50 cards per minute and group print at the rate of 50 cards per minute.

UNIVAC Accounting Machines. The UNIVAC Model 3 Alphabetical Tabulator is designed to translate and print the numerical and alphabetical data which has been punched in 90 column cards in any desired sequence. The Model 3 can list the data from individual cards, add, subtract, and

print totals. It also can print totals without listing the information from individual cards. This tabulator operates at a speed of 100 cards per minute.

Each Model 3 Tabulator contains up to 100 type bars or sectors which contain 10 numeric, 26 alphabetic, and 1 special character. The horizontal arrangement of the printed data can be varied by the use of specially designed removable wiring units. The printing of totals is accomplished by the manual setting of devices which are an integral part of the tabulator. Figure 14 illustrates the Model 3 Tabulator with the UNIVAC 311 Summary Punch connected.

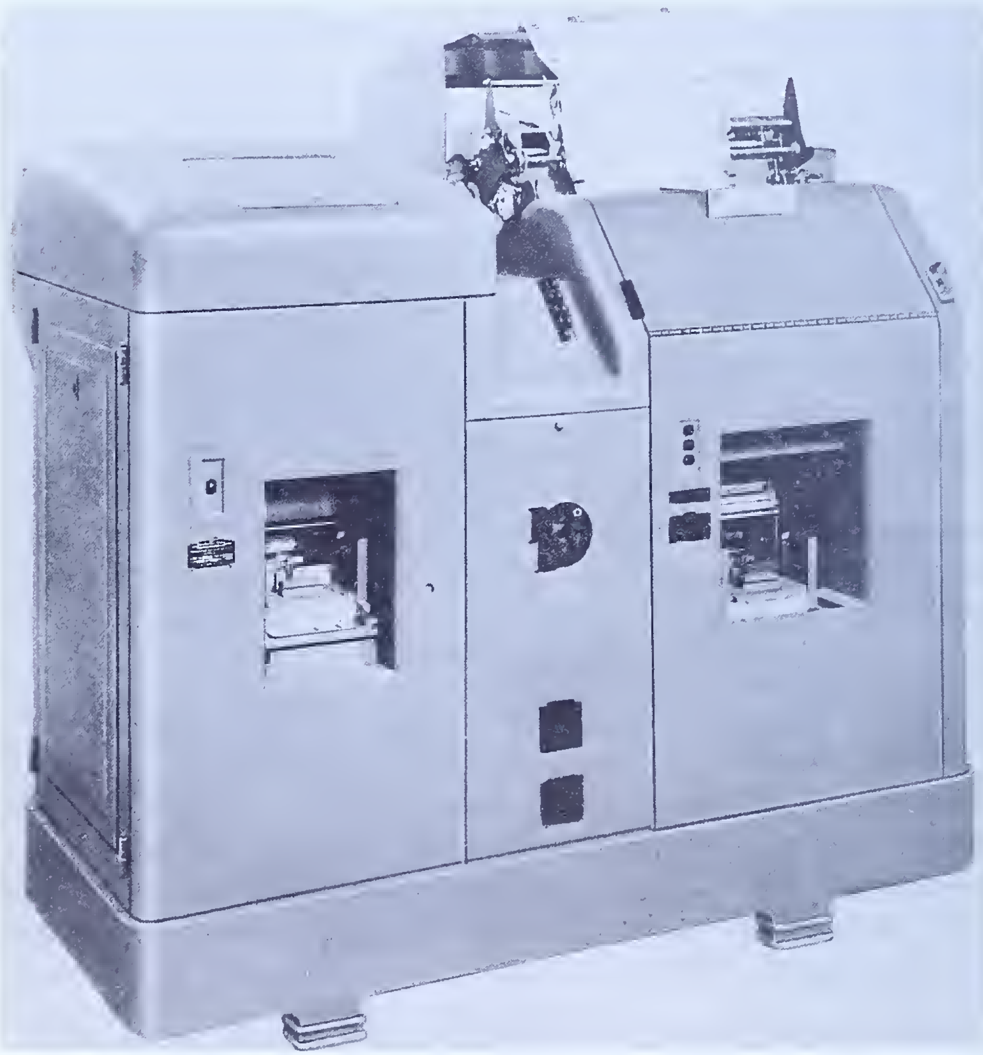

Figure 14. Accounting Machine

Calculating Punches

Since numerous arithmetic computations are required in the typical data processing system, calculating punches are employed to reduce the mechanical handling of this information. Various types of calculating punches have been developed and each is capable of automatically performing addition, subtraction, multiplication and division. Data can be read from one set of cards and the results punched into the same or a different set of cards. The operation of all calculating punches is regulated by a control panel which can be programmed to solve specific problems. Calculating punches are not widely used in business offices. It is often found that computers can perform the somewhat limited functions of the calculators in addition to performing a wide range of other operations which make a computer the more desirable piece of equipment.

Control Panels (Wiring Boards)

Control panels serve as the means of directing unit record equipment to perform their respective functions. Generally all unit record equipment except key punches, verifiers, and sorters are equipped with control panels. Key punches and verifiers are directed by program cards, and sorters are controlled by internal mechanisms.

The supervisor of the data processing installation usually handles control panel wiring, and machine operators sometimes are called upon to make minor adjustments. However, pre-wired control panels recently have been made available by companies supplying data processing accessories. The future offers considerable promise for widespread utilization of pre-wired control panels.

CHAPTER TEN

Computers

In Chapter VI consideration was given to the effect of data processing on the paper explosion. As indicated, manual and even mechanical equipment have made little progress in coping with the tremendous avalanche of paper which has become a national problem.

Computers are being used in the business office as a means of meeting the growing need for information under increasingly complex conditions, and wherever repetitious calculations and the processing of voluminous data become routine. They are used extensively and have their greatest applications in the commercial, scientific, and military fields. Speed, accuracy, and the availability of information are the prime beneficial aspects.

These electronic devices have been integrated with common language media as discussed in Chapter VIII and unit record equipment as discussed in Chapter IX; this is identified as an electronic data processing system. Computers have been designed to handle business or scientific data at electronic speed with self-checking accuracy. An illustration of a computer may be found in Figure 15.

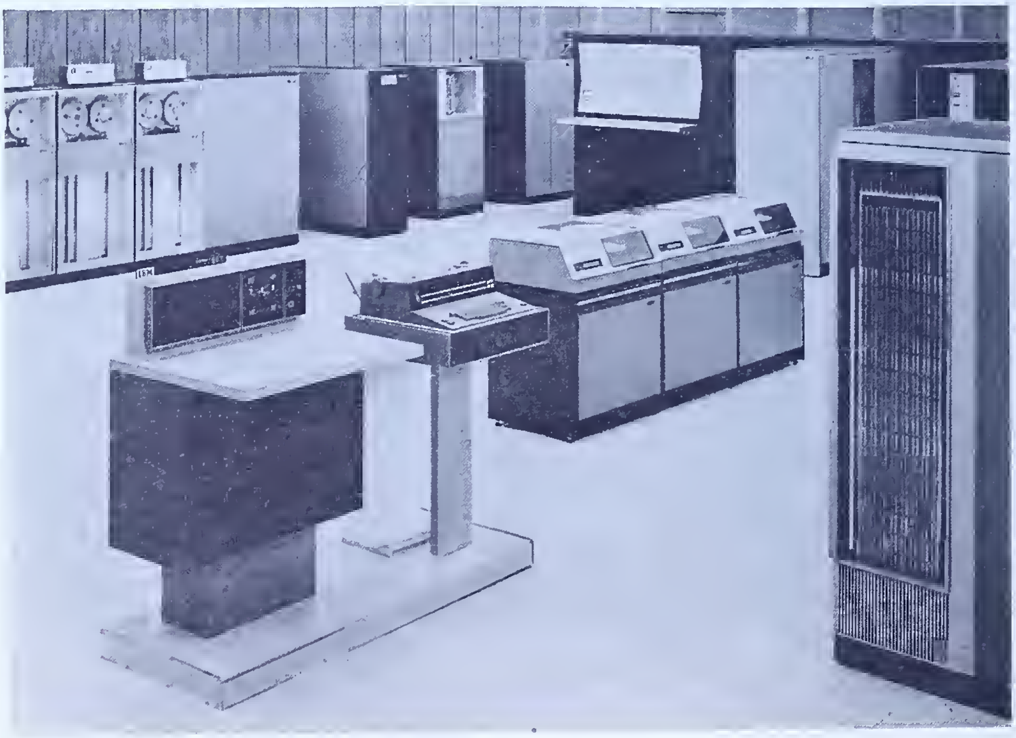

Figure 15. Computer

Although addition is the basic arithmetic operation performed, computers are capable of subtraction, multiplication, and division. They also have the facility to test for various conditions through a comparing feature. Computer calculations are performed according to a series of detailed instructions called a program. Programs take the form of languages which can be understood and acted upon by computers. Three of the more widely used computer languages are COBOL (*Co*mmon *B*usiness *O*riented *L*anguage), FORTRAN (*For*mula *Tran*slation System), and SPS (*S*ymbolic *P*rogramming *S*ystem).

Digital and Analog

A digital computer uses digits or numbers to represent data in its calculation process. In another sense, the digital computer can be thought of as a device for determining quantity (how many). Therefore, the digital computer is the one that is used most often by business for the processing of data. Through the manipulation of numbers, digital computers can compute sales data, costs, payroll, and other information of an accounting nature.

An analog computer determines quantity (how much) by measurement. Data are applied in the analog computer in the form of variable voltages, such as rotation, speed and sound, and air resistance. Because of their ability to quickly and accurately process complicated mathematical and scientific data, analog computers have their greatest applications in industrial process control, power distribution, and simulation.

Special and General Purpose

The special purpose computer is built for a specific operation and usually for a single customer. This machine may incorporate many of the features of a general purpose computer with specific features for handling a particular problem. The most widely known special computer is the ERMA (*E*lectronic *R*ecording *M*achine-*A*ccounting) system which was built for the Bank of America by General Electric. In the ERMA system, checks and deposit slips are read using *m*agnetic *i*nk *c*haracter *r*ecognition (MICR) to identify account numbers, and amounts are deducted or added to the proper accounts as necessary. Other special computers include the devices used for collecting tolls on highways and for controlling traffic and reservations in the airlines industry.

General purpose computers are built to perform a variety of jobs. Since they are not really tailor-made, the general purpose computer has the advantage of lower cost and better service. Digital computers usually fall into the general purpose category, while most analog computers are special purpose machines.

Serial and Parallel

Serial computers perform arithmetic operations by considering one digit at a time, similar to the manner in which long-hand addition is performed. Even though their operating speed is considerably slower than parallel computers, serial machines are commonly used in business offices.

Parallel computers perform parallel addition by considering a total field of information at one time. As a result, parallel machines perform faster than those employing the serial addition concept. Parallel addition is the type used most often in large-scale scientifically oriented computers which have been specifically designed to perform selected operations.

Buffered and Unbuffered Systems

A buffer is a particular device used to retain information (temporarily) being transmitted between external and internal storage units, or input-output devices and internal storage. A buffered system permits all three functions (read, compute, and write) to proceed simultaneously on different items. It can read information while it is making computations on that information and writing results of the total operation.

Not all computing systems are equipped with buffer facilities. Since an unbuffered system does not have this additional feature, it would be able to perform only one command at a time in serial fashion. For instance, an unbuffered system would complete a read, compute, and write command in the following manner: read all information, compute all information, and then write all information.

Sequential and Non-Sequential

A computer is classified as being sequential when the instructions comprising the program are accessed in a consecutive manner. On a sequential computer, the programmer need not direct the computer to the location of an instruction unless he specifically wishes to interrupt the general sequence. Most computers in use today operate in this fashion.

In non-sequential machines, the computer must be directed by the programmer to the location of each instruction. Failure to specify the location of each instruction usually will result in improper operations because the computer will not automatically proceed from one instruction to the next sequentially.

Computer Characteristics

Basically, all electronic computers are composed of five units or parts which perform five operations: input, storage, logical-arithmetic, control, and output. The storage, logical-arithmetic, and control units are referred to as the *c*entral *p*rocessing *u*nit (CPU). The operation of each unit as indicated in Figure 16 is dependent upon the others and all are under the direction of the control unit. The following is a brief description of these units:

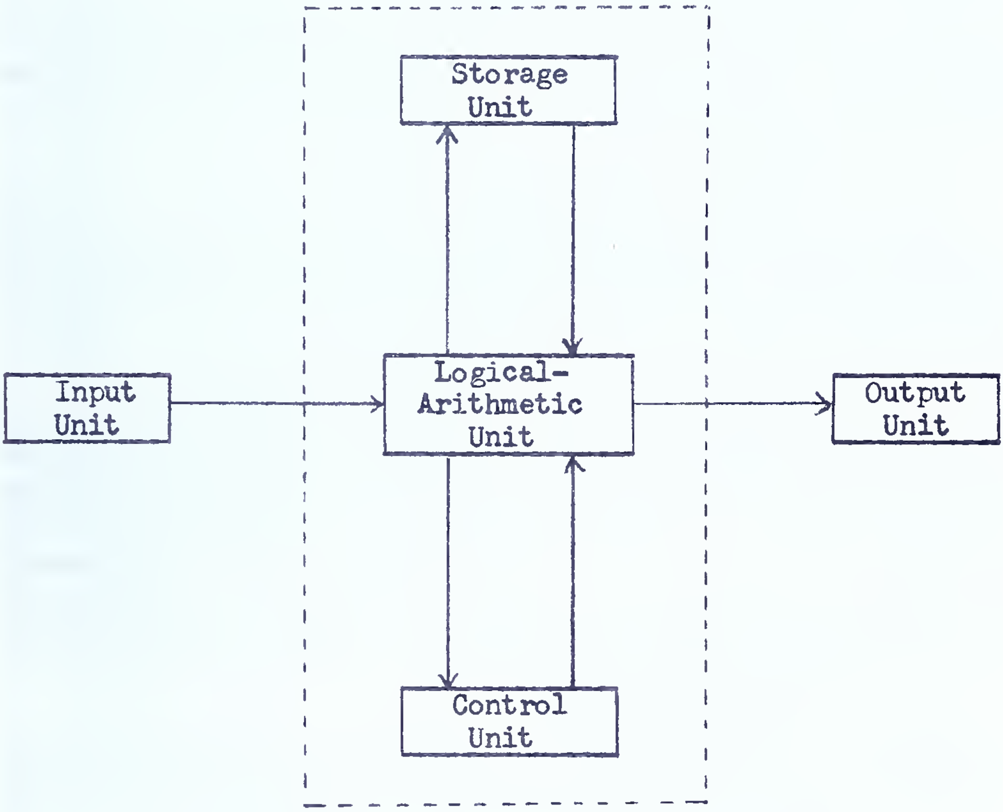

Figure 16. Elements of a Computer

Input. The purpose of the input unit is to accept the initial information required to solve the problem. It is the means of communicating with the computer. Data for input are recorded on punched cards, paper tape, magnetic tape, magnetic ink characters, or inserted into the computer manually by means of a typewriter keyboard. Cards are the most flexible and extensively used input device since they can be checked readily for accuracy. Magnetic tape is the most widely used medium employed in the large scale electronic computing system because of its processing speed.

Storage. Storage or memory unit is completely indexed, almost simultaneously accessible to the computer, and similar to an electronic filing cabinet. There are three major types of storage. First, internal storage is the integral part of the computer system mentioned above. It has the ability to accept, hold, and release data and instructions on demand from the control unit. Second, auxiliary storage devices are outside the central processing unit, but are directly controlled by it. These devices include magnetic disks, drums, and tape. Third, external storage facilities are apart from the central processing unit entirely. These devices take the form of the input media discussed above.

All data are placed in the internal storage unit before they can be processed by the computer. Each storage location (address) is numbered sequentially so the stored information can be located readily by the computer as it is needed.

The size or capacity of the internal storage unit determines the amount of information that can be held within the system at any one time. The size of the units varies from those which can handle thousands of digits or characters to those whose storage capacity is measured in millions of bits of information.

Logical-Arithmetic. The logical-arithmetic unit is often referred to as the heart of the computer. It is the unit which performs all computations. The arithmetic section gives the computer the ability to perform the arithmetic operations of adding, subtracting, multiplying, and dividing. The logical unit gives the computer the power to make logical decisions by distinguishing between positive, negative, and zero values. The mathematical symbols $>$ greater than, $<$ less than, and $=$ equal to are the tools employed in this comparing procedure.

Control. The control unit performs the most vital function in the computing system. It is the section which directs and coordinates the entire system as a single multipurpose machine. It actuates the other units and controls the data flow between them to solve a problem. The control unit performs two basic functions. It accepts data from storage, and operates on the instructions as given by the programmer.

Output. The output unit or device is the means by which the desired results of the problem are obtained. The more common forms of output units are card punches, magnetic-tape writers, paper-tape punches, printing units, and typewriters.

The input-output devices employed with the computer depend on the design of the system and its general application. Input-output devices connected directly to the computer are called on line, while those not directly connected are called off line.

Binary System

Computers are capable of extremely rapid data processing activity, and discharge their functions in a somewhat elementary way. The method of computation employed by most electronic computers is referred to as the binary system since the internal components indicate two conditions, either on or off. The binary system is based on a two-digit system, represented by the symbols 1 and 0 which express the on or off condition. This procedure is similar in principle to the operation of a light bulb. For example, a light bulb functions in a binary mode—it is either on, producing light; or off, not producing light. Indicating the presence or absence of data by means of the 1 and 0 symbols, vacuum tubes or transistors either conduct or do not conduct current. The binary digits, 1 and 0, have the same significance in the binary system as in the decimal system.

Single and multiple-digit decimal numbers are expressed by the position value of the bit symbols (1 and 0) which are based on the progression of powers of two: the unit position of a binary number (at the extreme right) has the value of 1, the next 2, the next 4, the next 8, etc. This system of coding or formally expressing decimal digits in an equivalent binary value is known as the *b*inary *c*oded *d*ecimal (BCD). In the illustrations below, note the on or off representation by means of the 1 and 0 symbols.

1	0 0 0 0 0 0 0 0 0 0 1
2	0 0 0 0 0 0 0 0 0 1 0
4	0 0 0 0 0 0 0 0 1 0 0
8	0 0 0 0 0 0 0 1 0 0 0
16	0 0 0 0 0 0 1 0 0 0 0
32	0 0 0 0 0 1 0 0 0 0 0
64	0 0 0 0 1 0 0 0 0 0 0
128	0 0 0 1 0 0 0 0 0 0 0
256	0 0 1 0 0 0 0 0 0 0 0
512	0 1 0 0 0 0 0 0 0 0 0
1,024	1 0 0 0 0 0 0 0 0 0 0

Each of the ten digits found in the decimal system is represented in the binary system as illustrated below.

Decimal Digit	*Binary Notation*
0	0 0 0 0
1	0 0 0 1
2	0 0 1 0
3	0 0 1 1
4	0 1 0 0
5	0 1 0 1
6	0 1 1 0
7	0 1 1 1
8	1 0 0 0
9	1 0 0 1

On the basis of the place value of binary numbers, the following decimal numbers would be expressed in this manner:

Decimal Number	*Binary Equivalent*
15	0 0 0 0 0 1 1 1 1
96	0 0 1 1 0 0 0 0 0
130	0 1 0 0 0 0 0 1 0
385	1 1 0 0 0 0 0 0 1

Conversion from binary system to decimals is readily accomplished, and any binary number can be translated into decimal form. Beginning with the digit on the extreme right, indicate the position value of a digit that is a 1 and disregard a digit that is a 0. Next, add the position values to find the answer. Converting a binary number into decimal form is illustrated below:

$$
\begin{array}{lr}
1\ 1\ 0\ 0\ 1\ 1\ 0\ 0\ 1\ 1 = 819 \qquad & 1 \\
 & 2 \\
 & 16 \\
 & 32 \\
 & 256 \\
 & 512 \\
\hline
 & 819
\end{array}
$$

The process of converting a number from decimal form into the binary system is more complicated. A suggested method is to divide the decimal number by 2. Record any remainder as 1, and if there is no remainder, record a 0. Then, subsequently divide each quotient by 2 until there is no quotient. It is important that the remainder (1) or no remainder (0) be recorded in each step. Translating 819 into the binary system can be accomplished as follows:

$$\begin{aligned}
819 \div 2 &= 409 \text{ R } 1\\
409 \div 2 &= 204 \text{ R } 1\\
204 \div 2 &= 102 \text{ R } 0\\
102 \div 2 &= 51 \text{ R } 0\\
51 \div 2 &= 25 \text{ R } 1\\
25 \div 2 &= 12 \text{ R } 1\\
12 \div 2 &= 6 \text{ R } 0\\
6 \div 2 &= 3 \text{ R } 0\\
3 \div 2 &= 1 \text{ R } 1\\
1 \div 2 &= 0 \text{ R } 1
\end{aligned}$$

Reading the last column starting from the bottom, the number 819 would be represented in the binary system as 1 1 0 0 1 1 0 0 1 1.

It is believed that arithmetic computations can be performed as easily with the binary system as they can with the decimal system since the mechanics are basically the same. When the limit of any digit position is reached and one more is added, counting in the same digit position must begin again at 0 with a carry of 1 to the next higher-order position. Since there are only two symbols, 1 and 0, in the binary system the limit of any digit position is reached when a 1 is present. Adding one more unit to that digit position then results in a sum of 0 and a carry of 1 to the left, into the next higher-order position.

In the addition of binary numbers, three basic rules must be kept in mind:

1. Zero plus zero equals zero.
2. Zero plus one equals one.
3. One plus one equals zero, with a one carry.

As an example, adding eleven, seven, and five in binary would appear:

$$\begin{array}{r l}
1\ 0\ 1\ 1 & = \text{eleven}\\
1\ 1\ 1 & = \text{seven}\\
1\ 0\ 1 & = \text{five}\\
\hline
1\ 0\ 1\ 1\ 1 & = \text{twenty-three}
\end{array}$$

Beginning at the extreme right, one plus one equals zero with a one carry, and the zero plus one equals one which is recorded. Remember, as you add the second column from the extreme right that there is a one carry.

Subtraction in binary is equally as simple; the following rules apply:

1. Zero minus zero equals zero.
2. One minus zero equals one.
3. One minus one equals zero.
4. Zero minus one equals one, with one borrowed from the left.

Observe how these rules are applied in the following example in which twelve is subtracted from twenty-two:

$$\begin{array}{ccccccl}
1 & 0 & 1 & 1 & 0 & = & \text{twenty-two} \\
 & 1 & 1 & 0 & 0 & = & \text{twelve} \\
\cline{1-5}
 & 1 & 0 & 1 & 0 & = & \text{ten}
\end{array}$$

In the multiplication process, the following rules apply:

1. Zero times zero or one equals zero.
2. One times one equals one.

For example, multiplying six times six would appear:

$$\begin{array}{cccccccl}
 & & & 1 & 1 & 0 & = & \text{six} \\
 & & & 1 & 1 & 0 & = & \text{six} \\
\cline{4-6}
 & & & 0 & 0 & 0 & & \\
 & & 1 & 1 & 0 & & & \\
 & 1 & 1 & 0 & & & & \\
\cline{1-6}
1 & 0 & 0 & 1 & 0 & 0 & = & \text{thirty-six}
\end{array}$$

Applying the rules already stated for multiplication and substraction, division of binary numbers proceeds as in decimal arithmetic.

$$\begin{array}{lcccccl}
 & & & 1 & 1 & = & \text{three} \\
\cline{2-5}
\text{five} = 1\ 0\ 1 & 1 & 1 & 1 & 1 & = & \text{fifteen} \\
 & 1 & 0 & 1 & & & \\
\cline{2-4}
 & & 1 & 0 & 1 & & \\
 & & 1 & 0 & 1 & & \\
\cline{3-5}
\end{array}$$

Conclusion

The main purpose of this chapter is to consider computer characteristics and give the reader a background knowledge of electronic computers. No attempt was made to discuss specific computer systems. Since the computer industry is progressing at such a tremendous rate and probably the only essential feature that can be discussed with much certainty is the element of change itself, it was decided to approach the topic in this light.

The rapid and fantastic developments in the computer and data processing fields pose a significant challenge to business educators. Secondary schools need to accept more responsibility for preparing pupils for employment in business offices using data processing equipment. If America's educational system keeps pace with technological progress, it will help pave the way for a richer and higher civilization than man has known.

APPENDIX A

Glossary

The definitions in this part of the glossary are presented to identify the more common data processing terms which are found in the content matter of this bulletin.

address. A register, location, or device in which information is recorded.

alphamerical. A coding system capable of representing alphabetic characters, numerals, and other symbols in combinations.

analog computer. A computer which calculates numerical quantities by means of physical variables, such as voltage, resistance, and speed. An analog computer is used primarily in scientific research.

automatic data processing. A system that utilizes such equipment as key punches, sorters, accounting machines, as well as electronic computers, to store and process data. Employs a minimum of manual operations in handling data.

automatic punch. A mechanical data processing device capable of punching a new set, or file, of cards from an original set of cards.

automation. The entire field of investigation, design, development, application, and methods of making processes or machines self-acting or self-moving.

binary number. A single digit or group of characters or symbols utilizing the base two—"1" or "0" digits—to express an "on" or "off" condition.

bits. A combination of binary digits; hence, units of data in binary notation. Abbreviated from *BI*nary digi*TS.*

chip box. A container on such equipment as card punches and reproducers to accumulate card chips from the punching process.

cipher control. Levers which regulate the printing of zeros, and permit the automatic printing of zeros which have not been previously punched in a card.

COBOL. An English-like programming language designed primarily for use in business-type applications. Abbreviated from *CO*mmon *B*usiness *O*riented *L*anguage.

code. A system of symbols and their use in representing rules for handling the flow or processing of data.

coded. Use of a system of rules and symbols to represent data or operations.

column indicator. The pointer showing the column to be punched or read in a card punch, verifier, or sorter.

common language media. Information which can be sensed and processed by a machine; takes the form of punched cards, paper tape, or magnetic tape.

computer. A device capable of accepting data, applying prescribed processes to them, and supplying the results of these processes; the central unit of an electronic data processing system.

data. A collection of facts; information; numerical or alphabetical characters.

data processing. Rearrangement and refinement of raw data into a form suitable for future use.

debug. To diagnose and correct malfunctions or mistakes in a computer program.

detail printing. Often identified as listing; involves printing information from each card passing through the accounting machine.

digital computer. A computer which performs mathematical operations in sequence at high speeds according to a set of instructions; information is expressed as digits or letters; used extensively in business concerns for processing data.

electronic data processing. The use of high speed electronic computers in a data processing system; a machine system capable of receiving, storing, computing, and recording data without the intermediate use of punched cards.

field. A set of one or more characters constituting a unit of data; a set of one or more columns on a punched card used to record similar information.

fields. A group of columns of data allocated for punching specific information.

first interpretation. Printing on a card the information that has been punched in the card. The first interpretation prints the first 60 positions on an IBM card and the first 45 positions on a UNIVAC card.

flagged. A process of differentiating one item from another; a selection according to predetermined characteristics.

FORTRAN. A computer language and translator designed for programming problems expressed in a mathematical-type language. Abbreviated from *FOR*mula *TRAN*slation system.

gang punch. Punching identical information into a group of punched cards.

group printing. Printing information identifying a group; printing only totals as punched cards pass through an accounting machine.

input. Information which is transferred from auxiliary storage or external storage into the internal storage of a computer; takes the form of punched cards, paper tape, or magnetic tape.

integrated data processing. A system that eliminates all repetitive handling of data through punched cards, paper tape, or magnetic tape; an approach to data processing.

magnetic tape. A storage medium consisting of metal, paper, or plastic tape coated with magnetic material; information is stored as small magnetized spots arranged across the width of the tape.

mark sensing. Recording information with a high-graphite content pencil and punching this information on automatic punches.

micro-electronic circuits. The internal workings of an electronic computer which give it the ability to calculate and transmit data at speeds of a thousandth of a second.

multiple-line print (MLP). Printing more than one line from a card passing through selected accounting machines.

output. Information transferred from the internal storage of a computer to secondary or external storage; information produced from the computer in the form of reports or statements.

paper tape. A specially treated strip of paper in which a pattern of holes is punched; this pattern represents numbers, letters, and symbols. Usually contains 5 to 8 positions (channels) per column.

partial interpretation. A mechanical process in which the machine (interpreter) can be set up to interpret only selected information instead of the entire card.

printing lock-out. Controls on an interpreter which can either allow or prevent the printing of information.

procedure. A manner or method of achieving desired results; a particular way of proceeding.

program. A plan for the solution of a problem that includes a series of instructions directing the computer to perform specific functions.

programmer. Initiates the plan for the solution of a particular problem; prepares instruction sequences.

program unit. The card-controlled mechanism on a card punch or verifier for controlling the automatic operations (skipping and duplicating).

punched card. A card of standard size and shape upon which data may be stored in the form of punched holes. Additional explanation follows:

a. *card column.* One of the vertical areas in which a unit of information may be recorded.

b. *card row.* One of the horizontal positions in which a unit of information may be recorded.

c. *nine edge.* A term used to designate the bottom or lower edge.

d. *numeric punch.* The area occupied by the digits 0—9 in a vertical column.

e. *twelve edge.* A term used to identify the upper or top edge.

f. *zone punch.* The area which records alphabetic characters when used with the digit punch; top three positions on a card—the 12, 11, and 0 positions.

read. To sense the meaning of arrangements of information; to copy, usually from one form of storage to another.

SPS. A computer language system used to simplify the preparation of programs where names, characteristics of instructions, or closely related symbols are used in writing a program. For instance, the term WATY, is the code for instructing the computer to *w*rite *a*lphamerically on the *ty*pewriter. Abbreviated from *S*ymbolic *P*rogramming *S*ystem.

second interpretation. Printing the last 20 columns of information on an IBM punched card and the last 45 columns on a UNIVAC punched card. *See* first interpretation.

sorter. A mechanical device capable of arranging cards in a predetermined sequence according to the punching in a card.

source. An original document that includes raw data in the form of business papers.

storage. A device capable of receiving data, retaining them for an indefinite period of time, and supplying them upon command.

summary punching. Preparation of one total card on an accounting machine which represents the accumulation of a group of related cards; reduces the over-all card volume and accelerates the preparation of periodic reports.

system. A regular or special method or plan of procedure; consists of an organization, people, equipment, and procedures that operate together to perform a set of tasks.

tabulating. Producing lists, tables, and totals on separate forms or continuous paper from another medium; e.g. punched cards, paper tape, and magnetic tape. Generally refers to the operation of the accounting machine.

tiny transistors. Miniature electronic devices utilizing semi-conductor properties to control the flow of currents from a source in one circuit by currents from another circuit.

unit record. A record in which all the data concerning a particular item are punched into one card; a system incorporating various mechanical equipment to process data.

verify. To check, usually with an automatic machine, one recording of data against another to minimize the number of errors in the data transcription.

write. To transfer information from computer storage to an output device.

The following terms which have not been included in the content matter of this bulletin also are used rather frequently in data processing.

down time. Period during which a computer is not in operation because of machine failure.

edit. To arrange or rearrange information. Involves the deletion of unwanted data and the selection of pertinent data through the process of examination for completeness and correctness.

hardware. The mechanical, magnetic, electronic, and electrical devices from which a computer is fabricated. Consists of cabinets, tubes, transistors, and motors.

software. Programming aids used to facilitate the efficient operation of data processing equipment, namely electronic computers.

APPENDIX B

Questions and Projects

The questions and projects included in this section of the bulletin have been developed to help teachers evaluate pupil understanding of data processing.

Discussion Questions

Teacher should consider the background and experience of their pupils when these questions are being used. The Roman numeral after each question indicates the chapter in which the problem is discussed.

1. Discuss the turnover of clerical workers and its effect on training programs by computer manufacturers. (II)
2. Identify the GIGO concept and comment on its significance in the business office. (II)
3. List and describe the basic competencies needed by those who seek employment in the field of data processing. (II)
4. Discuss the value of algebra for those who plan to work with computers. (II)
5. Explain why it is important to have a background in bookkeeping and accounting if you plan to enter the field of data processing. (II)
6. Identify the following men:
   a. Charles Babbage
   b. Herman Hollerith
   c. James Powers
   d. Howard H. Aiken
   e. John W. Mauchly
   f. J. Presper Eckert (III)
7. Identify the following computers:
   a. Mark I
   b. Eniac
   c. UNIVAC (III)
8. Contrast the internal components of early computers with those most recently developed. (III)

9. Discuss possible uses of computers in the future. (III)

10. Comment on the use of computers in the home. (III)

11. Consider the effect of data processing on office work, in terms of communication and recordkeeping. (IV)

12. Why is the wise selection and analysis of data important? (IV)

13. Discuss the dependence of management upon data processing. (IV)

14. What will be the effect of data processing on office employment? (IV)

15. Why does the installation of a computer eventually necessitate the hiring of a greater number of clerical employees? (IV)

16. Evaluate the following statement: "You should consider data processing as your servant and not as your replacement." (IV)

17. Discuss the role of computer service centers in the field of data processing. (V)

18. Identify specific applications which use data processing equipment. (V)

19. Discuss how Pennsylvania's Bureau of Motor Vehicles will use a computer system. (V)

20. Comment on the role of the MICR system in the banking business. (V)

21. Describe how data processing can be used in the field of real estate. (V)

22. Why does paper work continue to grow at a rapid rate of speed? (VI)

23. Indicate some examples of the extensiveness of the paper explosion. (VI)

24. On a national basis how do you think it might be possible to reduce the amount of paper that presently is being used. (VI)

25. Discuss the statement: "We live in a paper age." (VI)

26. Contrast the three levels of work in data processing. (VII)

27. Referring to the *Dictionary of Occupational Titles,* identify those jobs in data processing for which high school graduates can qualify; those which require a college degree. (VII)

28. Discuss the responsibilities of a key punch operator. (VII)

29. What type of work is performed by a peripheral equipment operator? (VII)

30. Why is human ability so important for one who aspires to enter data processing? (VII)

31. What are common language media? Discuss their use in eliminating the duplication of effort in office work. (VIII)

32. Define the following terms:
    a. Integrated data processing
    b. Input
    c. Output
    d. Source documents (VIII)

33. Discuss the significance of corner cuts on punched cards. (VIII)

34. Define the term "field" as it is used in recording information in a punched card. (VIII)

35. Comment on the major differences between the IBM and UNIVAC punched cards. (VIII)

36. Define the term, automatic data processing. (IX)

37. Contrast the operation of the IBM 026 with the UNIVAC 306-2. (IX)

38. Describe the operation of interpreters, and discuss the need for a second interpretation. (IX)

39. Describe the sorting of alphabetic information on the IBM 083 Sorter. (IX)

40. Discuss the function of the control panel on the UNIVAC 420 Electronic Sorter. (IX)

41. List and discuss the four basic functions of automatic punches. (IX)

42. Identify the following functions of collators:
    a. Matching
    b. Merging
    c. Selecting
    d. Sequence checking (IX)

43. Explain the difference between detail and group printing on accounting machines. (IX)

44. Discuss the functions of calculating punches. (IX)

45. Identify two of the more widely used computer languages. (X)

46. Differentiate between the following computer characteristics:
    a. Digital and Analog
    b. Special and General Purpose
    c. Serial and Parallel
    d. Buffered and Unbuffered

47. What are the five units or parts of the electronic computer? (X)

48. Discuss the function of the storage unit in the computer. (X)

49. Discuss the function of the control unit in the computer. (X)

50. Describe the binary system in contrast with the ordinary decimal system. (X)

Class Projects

The following projects are included to provide pupils with an opportunity to gain some experience in using the tools of data processing. Projects 1 through 4 pertain to Chapter VIII, 5 through 15 to Chapter IX, and 16 through 22 to Chapter X. Where applicable, the answers are included at the end of the exercise.

1. Collect or prepare facsimiles of
    a. IBM card
    b. UNIVAC card
    c. Paper tape
    d. Magnetic tape
    e. Magnetic ink characters

2. Write the term data processing in:
    a. IBM card code
    b. UNIVAC card code

3. Interpret the following information presented in the IBM card code.

12	12	12	11	0	11	0	12	11	12
1	3	3	6	4	5	3	9	5	7

11	12	12	12	12	11	12	0
4	1	3	8	9	5	5	2

4. Interpret the two words presented below in the UNIVAC card code.

1	0	0	1	0	0	1	1	1
5	3	7	3	5	3	5	7	3
7				9	5	9		9

1	0	3	1	1	0	1
5	7	7	3	3	9	5
7						7

5. Plan appropriate field designations for the data given below. Using a key punch or a pencil, compute the invoice amounts and prepare one card for each item.

a. 78 pairs gloves	@ $5.50
b. 15 pairs hose	@ $1.80
c. 280 sheets	@ $2.90
d. 50 brushes	@ $1.25

6. Design a punched card by designating fields and preparing appropriate headings for recording the following information:
   a. Name of your school
   b. Your last name, followed by your first
   c. Name of your city
   d. Name of your state

7. Design or punch a verified IBM card in which an error appears in column 25.

8. Design or punch a verified UNIVAC card in which no errors appear.

9. Using a key punch or a pencil, prepare individual cards from the sales reports presented below. Identifying headings (card columns) are indicated.

Card Columns

1	8	18	26	33
Salesman Number	*Sales*	*Product Number*	*Customer Number*	*Customer Name*
16	$ 288.66	201	24	Jones, Peter
3	651.30	585	18	Brown, Jesse
20	96.17	311	25	Wilson, Harold
11	30.60	323	22	Jacobs, Donald
9	380.70	102	7	Smith, Adam
13	132.25	203	17	David, Arthur

   a. Sort the cards, arranging them according to salesman number
   b. Sort the cards, arranging them according to sales
   c. Sort the cards, arranging them according to product number
   d. Sort the cards, arranging them according to customer name

10. If an automatic punch is available, duplicate the deck of cards prepared in the last problem.

11. Having duplicated the original deck, use the two decks of cards to perform the functions indicated below on a collator. Arrange cards according to customer number.

a. Match the two decks to verify that each card has been properly duplicated.
b. Merge the two decks into one complete file.
c. Sequence check the merged deck to verify that it has been properly arranged in ascending order.
d. Select the first of each of the matching cards.

12. Print out a copy of the two decks on the accounting machine (tabulator), under each of the following methods:
    a. Detail printing
    b. Group printing
    c. Summary punching (on the automatic punch)

13. Using a key punch or a pencil record the following figures on a punched card. (If a pencil is used, shade the areas in which punches would appear.) One card should be prepared for each line of figures.

Card Columns

1	6	11	16	21	26	31	36	41	46
1234	5678	9123	4567	8910	7654	3210	8976	5418	9977
4526	2654	6245	5426	6516	1655	5564	4513	5234	2451
0024	3546	8907	0786	5467	5492	0789	2300	5642	5075
9776	5648	9796	5324	8760	7643	7621	9655	8977	8514
1471	2582	0369	5822	4285	0893	7472	4637	2818	1234
9630	1417	4097	1753	2091	4377	7484	9286	7114	7865

14. Using a key punch or a pencil, prepare a program card and the detail cards for the following employees. Each line of information is to be recorded on a separate card.

Card Columns

1	20	28	36	44	52	60	68
Ambroso, B. M	00234	56784	89070	78654	67549	00789	23000
Bathman, E. O.	00045	34578	76544	00897	78654	77893	00989
Callaway, G. N.	90067	97865	56438	56978	86543	67543	97685
Dawson, L. C.	06549	78600	08876	79865	76654	78659	08976
Evans, E. R.	97643	76658	98776	96657	64332	33242	56443
Fine, H. B.	00009	86554	33678	96554	89765	76590	86544

15. Using a key punch or a pencil, prepare a program card and the detail cards for the following employees. Each line is to be recorded on a separate card.

Card Columns

1	9	18	23	29	34
Employee Number	*Earnings to Date*	*Hours Worked*	*Hourly Rate*	*Dependents*	*Employee Name*
10000	356172	42	275	09	Adams, John
10001	495226	44	275	02	Lee, Gary
10002	475229	40	250	04	Smith, Mary
10003	395268	46	300	08	Bates, Samuel
10004	469393	40	250	04	Rockwell, Ted
10005	501679	45	316	03	Jones, Shirley

16. Draw a diagram illustrating the five major elements of a computer.

17. Express the following binary numbers in decimal form.
    a. 1010
    b. 11100
    c. 1111001
    d. 10010101
    e. 11101110

18. Give the binary coded decimal form for each of the decimal numbers listed below.
    a. 12
    b. 47
    c. 89
    d. 120
    e. 128

19. Add the binary numbers below.

a.	b.	c.	d.	e.
1011	1111	110110	011111011	11101101100
0111	0111	100010	100101010	01010111011

20. Subtract the binary numbers below.

a.	b.	c.	d.	e.
1111	101111	11100001	101111011	111001001
0010	010110	01011110	011111101	011110010

21. Multiply the binary numbers below.

a.	b.	c.	d.	e.
11	110	111	111	1011
01	011	101	111	0111

22. Divide the binary numbers below.
    a. 1111 ÷ 101
    b. 1000000 ÷ 1000
    c. 1100000 ÷ 11
    d. 10101010 ÷ 1010
    e. 10010000 ÷ 1100

Answers, of a specific nature, in the *Class Projects* are:

2. a.

D	A	T	A	P	R	O	C	E	S	S	I	N	G
12	12	0	12	11	11	11	12	12	0	0	12	11	12
4	1	3	1	7	9	6	3	5	2	2	9	5	7

b.

D	A	T	A	P	R	O	C	E	S	S	I	N	G
0	1	3	1	1	1	1	0	0	1	1	3	0	5
3	5	7	5	3	7	3	7	3	1	5	5	5	7
5	9	9	9	7					7	7		9	

3. Accounting machines

4. Secondary schools

17. a. 10, b. 28, c. 121, d. 149, e. 238

18. a. 1100, b. 101111, c. 1011001, d. 1111000, e. 10000000

19. a. 10010, b. 10110, c. 1011000, d. 1000100101, e. 101000100111

20. a. 1101, b. 011001, c. 10000011, d. 001111110, e. 011010111

21. a. 11 b. 10010 c. 100011 d. 110001 e. 1001101

22. a. 11, b. 1000, c. 100000, d. 10001, e. 1100

APPENDIX C

Instructional Aids

In a bulletin of this kind it is impossible to list all of the publications and films which are available in the area of data processing. Therefore, the instructional aids included herewith should not be considered exhaustive.

Publications

A partial listing of books that might be used as textbooks by pupils follows:

"Basic Machine Accounting," Dallas: Machine Accountants Training Association, 1963.

Johnson, Lloyd E., William E. Wadsworth, and John Burger, *Business Automation Fundamentals.* San Francisco: Automation Institute Publishing Company, 1961. 239 pp.

"Machine Accountant 3 & 2," Washington, D. C.: United States Government Printing Office, 1963. 267 pp.

Rice, Donald E., *Introduction to Data Processing.* Dayton: Washington Research and Development, 1962. 128 pp.

Wanous, J. J., and Edward E. Wanous, *Automation Office Practice.* Cincinnati: South-Western Publishing Company, 1964. 103 pp.*

A partial listing of books that might be used for reference purposes by teachers follows:

"Automatic Data Processing Glossary," Washington, D. C.: United States Government Printing Office, 1962. 62 pp.

Buckingham, Walter, *Automation.* New York: Harper and Row, Publishers, 1961. 196 pp.

Burroughs Corporation, *Digital Computer Principles.* New York: McGraw Hill Book Company, 1962. 507 pp.

"Electronic Data Processing in Engineering, Science, and Business," Washington, D. C.: United States Government Printing Office, 1963. 34 pp.

* A practice set accompanies this publication.

"Future Data Processors Instructor's Manual," Park Ridge, Illinois: National Machine Accountants Association, 1962.

Gregory, Robert H., and Richard L. Van Horn, *Automatic Data Processing Systems.* Belmont, California: Wadsworth Publishing Company, 1963. 816 pp.

"Introduction to Data Processing," New York: Haskins and Sells, 1957. 107 pp.

Laurie, Edward J., *Computers and How They Work.* Cincinnati: South-Western Publishing Company, 1963. 441 pp.

Martin, E. Wainright, Jr., *Electronic Data Processing—An Introduction.* Homewood, Illinois: Richard D. Irwin, Inc., 1961. 423 pp.

Nelson, Oscar S., and Richard S. Woods, *Accounting Systems and Data Processing.* Cincinnati: South-Western Publishing Company, 1961. 643 pp.

Randall, Clarence B., Sally W. Weimer, and Maynard S. Greenfield, *Systems and Procedures for Automated Accounting.* Cincinnati: South-Western Publishing Company, 1962. 616 pp.

Schrag, Adele Frisbie, and others, "Business Education for the Automated Office," *Thirty-Seventh Yearbook of the Eastern Business Teachers Association.* New York University Campus Stores, 1964. 279 pp.

Films

A partial listing of films that can be used in a data processing class follows:

AUTOMATION. U. S. Office of Education, Department of Health, Education, and Welfare, Washington, D. C. (30 minutes)

INTRODUCTION TO AUTOMATIC DATA PROCESSING. U. S. Department of Defense, Washington, D. C. (31 minutes)

PRINCIPLES OF ELECTRONIC DATA PROCESSING. International Business Machines Corporation, 590 Madison Avenue, New York, New York (16 minutes)

THIS IS AUTOMATION. General Electric Company, 13430 North Black Canyon Highway, Phoenix, Arizona (33 minutes)

WHAT DO YOU WANT? Sperry-Rand Corporation, 315 Park Avenue South, New York, New York (20 minutes)

Acknowledgments

Grateful appreciation is expressed for the assistance of the following business educators in the Commonwealth of Pennsylvania:

Robert D. Edwards, *Teacher of Business Education,* Palisades High School, Kintnersville

Curtis R. English, *Teacher of Business Education,* Senior High School, Williamsport

Arthur Hertzfeld, *Director of Commercial and Distributive Education,* Public School District, Philadelphia

Harry G. Jacobs, *Principal,* Shippensburg Area Senior High School, Shippensburg

Bernard J. McDonnell, *Supervisor of Commercial Education,* Public School District, Philadelphia

A. David Mayer, *Head of Data Processing Department,* Wilkes-Barre City Schools, Wilkes-Barre

James A. Parfet, *Head of Business Department,* Cumberland Valley High School, Mechanicsburg

Francis J. Radice, *Associate Professor,* State College, Bloomsburg

Adele F. Schrag, *Director of Business Education Department,* Temple University, Philadelphia

Department of Public Instruction personnel:

James J. Bruce, *Information Specialist*

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